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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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The Necessity for Defining-Terms.

A careful study of current foundry literature discloses a very interesting state of affairs. In the first place the output has recently grown enormously, as has obviously the number of lecturers and writers. The quality of their work and power of observation is rapidly reaching a high standard, but their reasoning is occasionally marred by the inclusion of loose and sometimes of incorrect statements of elementary basic principles. This is, no doubt, due to over-enthusiasm for their work. Another factor is a personal definition of a term which does not coincide with the generally-accepted meaning. Apparently, there exists a very definite need of some hyphenated expressions, in order to reduce confusion to a minimum. For instance, a lecturer may use the expression "porosity." Individuals may receive unconsciously the mental picture of sub-cutaneous blow-holes, deep-seated-blow-holes, mould-gas-blow-holes, core-gas-blow-holes, liquid-contraction-porosity or even pipe. The copious use of hyphens in this last sentence may appear to be pedantic on our part, but the common use by contributors to foundry literature of these and similar expressions would undoubtedly make for progress.

The average intelligent foundry manager will no doubt insist that it is extremely difficult to differentiate between the various phenomena carrying a common name. We are of opinion, however, that foundry research has reached such a stage that representative photographs could be published illustrating the difference in appearance and occurrence of the various types, with little additional work. In fact, a large collection already exist about which the essentials are sufficiently well known to enable the cause to be stated without departing from common ground.

This is essentially a fundamental research, and is one which would give, if presented in good style, much impetus to foundry progress. This is not the type of fundamental research understood in some circles, of which the results are incomprehensible to the people for whom it is designed to be of use. Associated with this latter type appears to be the provision of jobs, for academical workers uninitiated into industrial requirements, whilst the research we have indicated would provide a common jumping-off ground for the prosecution of the cure of defects as and when they arise in foundry practice. At the moment much time is spent in ascertaining as to whether the cause of porosity is ascribable to the mould, core, metal or other variables, whereas, if the foundrymen were in a position clearly to state the nature of the defect then the cure would be comparatively rapid.

To make ourselves clear. If in the centre of a heavy section there exists an open texture, exhibiting a dendritic structure, then the lecturer would refer to it as a "liquid-contraction-porosity," and in its cure no special consideration need be taken of the sands or venting, but attention could be confined to the densening of this section by using a metal of more suitable composition or other means.

Another example could be given of the porosity due to the presence of cores, almost wholly surrounded by metal, which are difficult of venting. If this defect could immediately be placed in its correct category by the foundrymen, then again its cure could be confined to within relatively narrow limits. Such a defect would be referred to as an insufficiently-vented-core-porosity. Once the basic characteristics of these various defects are universally recognised, then "wasters" will cease to have their present disturbing significance.

Correspondence.

Separation of Charges in the Cupola.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Replying to the above question, I might say that, in my experience with the cupola, I have found it impossible properly to separate the charges in the cupola.

This can easily be proved by melting a first charge of ordinary soft iron, followed by a charge of semi-steel, before the first charge is all melted and tapped from the cupola. Some of the steel of the next charge will have melted and mixed with the first charge, which can easily be seen by the firework display when tapping the metal from the cupola.

My practice now is to dispense with the double charge of coke, and work the various charges so that as little harm as possible is done by the mixing of the various charges in the cupola.—Yours, etc.,

A FOUNDRYMAN.

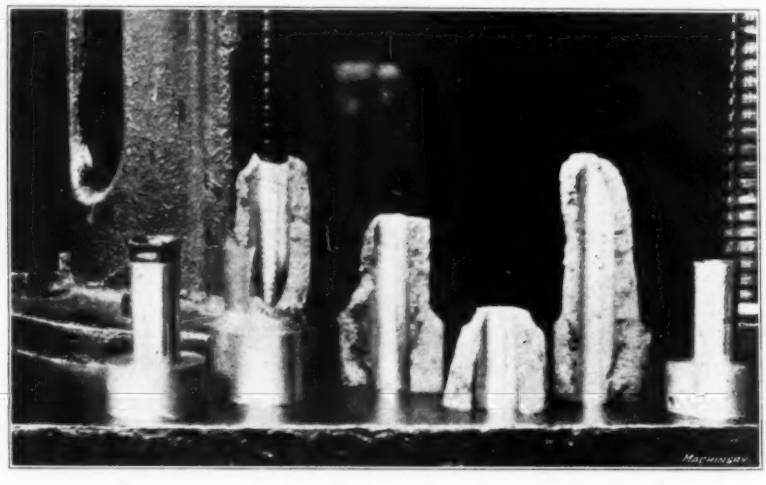
Strength of Cast-Iron Cylinders.

Cast iron is a notoriously difficult material with which to deal in a testing machine, in view of the fact that a considerable degree of uncertainty usually exists as to the point at which one may expect failure of the test piece during the loading process; and failure almost invariably occurs with startling violence.

The accompanying photograph is that of the broken fragments of a cast-iron cylinder, which was subjected to internal fluid pressure by the aid of a Riehlé screw power machine of 100,000 lbs. capacity.

The condition which it was sought to realise was the entire absence of longitudinal stress; and this was effected in the following manner. The enlarged ends of the test piece were bored to receive the plungers shown, as a sliding fit. The cylinder was packed with grease, the plungers fitted, and the whole placed between the compression heads of the machine.

Loading was then commenced and carried on up to a predetermined value, obtained by the use of an estimated stress for cast iron of the known dimensions. Beyond this the load was increased by very small increments, for each of which a condition of balance was carefully obtained, in order that any surface indications of failure might be observed. This was continued until fracture occurred; this came very suddenly and without any apparent initial deformation.



The burst occurred with considerable violence, cleavage occurring from the top and down approximately to the lower enlarged section, along three planes at about 120 degrees to each other. These three pieces were literally blown clean away from the lower portion, the fracture in each case showing a close-grained uniform surface. The casting was evidently an extremely good one, as is also indicated by the high stress attained.

As the cylinder was free to move on the plungers, the stress in a longitudinal direction was nil, and the stress equivalent to the greatest strain, which occurred in the direction of the maximum hoop tension, may be deduced by an application of the Lamé theory.

The following are the main observations made: External diameter of cylinder, $1\frac{3}{8}$ inches; internal diameter of cylinder, 1 inch; maximum load applied, 10,600 lbs.

Hence,

$$\text{Internal pressure} = \frac{10{,}600}{\frac{\pi}{4}}$$

$$= 13{,}500 \text{ lbs. per square inch.}$$

Substitution of the above values in the Lamé formula gives us, maximum stress (tensile) = 12.3 tons per sq. in.

It should be remarked that very great difficulty was experienced in preventing the escape of the grease when a considerable pressure was attained. Despite extreme accuracy in fitting the plunger, there was still a tendency for the grease to ooze out, but this was subsequently overcome by fitting a cup leather to the lower plunger. It is, of course, impossible to realise the condition of no longitudinal stress, if the cylinder presses down upon the shoulder of the plunger, either through escape during the test or an insufficiency of grease packed within the cylinder in the first place.

We are indebted to the Editor of "Machinery" for permission to publish this article.

Electric-arc Cleaning Bessemer Converter Spout.

During the blow a considerable quantity of the molten slag formed in a Bessemer converter is projected through the mouth of the vessel, and freezes around converter spout, which it gradually chokes. From time to time the slag obstruction has to be cleared, and since the upper portion is directly in line with the discharging gases, it is kept in a comparatively plastic state, and can be detached without much trouble by means of a long bar, using the working platform as a fulcrum. The lower portion of the slag mass, however, escapes the direct action of the flames, and is consequently frozen solid.

The method employed at the steel works at Senelle-Maubeuge and the Soudure Autogène Française for removing this frozen slag involves the use of an electric arc to split up the obstruction so that the separate parts are then easily removed by a bar. Metallic electrodes, about 1 in. dia. and 3 ft. long, are used, the electrodes being coated with a special material which, on melting, yields a fluid slag which quickly cuts a channel through the obstruction in the spout. Direct or alternating current may be used varying from 1,500 to 2,000 amperes, at a pressure of 100 volts. The converter is turned on its side, and connection is established by means of a short piece of rail sunk in the plastic mass and connected to one terminal of the source of current. To the other terminal is connected the electrode, which is rather heavy, and therefore it is supported on a hand rail or other suitable object. The whole operation, requiring two men, takes from 25-30 minutes, of which 10-12 minutes are taken up by the actual cutting. This method leaves the lining of the spout undamaged, and so lengthens its life considerably. With the old method sometimes it required the consumption of from 3 to 4 tons of coke to soften the slag, so that it could be detached. Moreover, it took at least two hours to accomplish. The temperature required was so high that the siliceous slag attacked the magnesite lining.

The Société de Senelle-Maubeuge estimates that from 60-70 tons of coke are saved per month. The electrical equipment is simple, step-down transformers for 3-phase, or motor generators for direct, current being employed. The outlay is moderate, and the plant quickly pays for itself.

Engineering Works of The Powell Duffryn Steam Coal Company, Limited.

The Tredomen Engineering Works, recently completed by the Powell Duffryn Steam Coal Company, Limited, are the largest self-contained engineering works in South Wales, and are also the largest and most complete engineering works directly controlled by a colliery company in the Kingdom. The site chosen for the works, Ystrad Mynach, is central to the Company's properties in the Aberdare and Rhymney Valleys. The road entrance to the works is on Tredomen Hill, and the sidings join up with the Rhymney Railway. The Works, comprising iron and steel foundries, brass foundry, machine, erecting and constructional shops, forge, pattern and electricians' shops, occupy with their yardage an area of 15 acres. The offices are contained in a ferro-concrete building immediately at the entrance.

FIG. 1.—ONE OF THE FOUNDRY BAYS.

The pattern shop and pattern stores occupy a separate building, the ground floor of which is used as a stores in which the whole of the patterns are carried in racks. Above the stores is the pattern shop, containing the usual assembly of tools, including plain grinders, lathes, band and circular saws, etc. A well in the floor communicates directly with the stores below.

The main portion of the works is covered by one building, 357 ft. long, with bays 42 ft. 4 in. wide. The bays are divided off with partition walls, but inter-communication between the shops is provided by lines of trolley track, furnished with turn-tables at intervals.

FIG. 2.—GENERAL VIEW IN MACHINE BAY.

The foundry is covered by two bays which are served by a 20-ton Broadbent and a 5-ton Royce crane respectively. The bays are common to both the steel and iron foundries, approximately half the length of the two being given over to each. The sand shop is contained in an annexe, the sand mills, etc., being driven from line shafting, which

is in turn driven by a 10-h.p. B.T.-H. motor. A Robinson 10-cwt. telpher is installed for delivering sand to any part of the foundry floor.

Steel is brought down in a 35-cwt. Tropenas converter, served by a Thwaites cupola. Blast for the converter is supplied by a Roots blower capable of delivering 3,500 cub. ft. at 3½ lbs. and

Fig. 3.—Heavy Machine Bay; Powell Duffryn Works.

driven by a 180-h.p. 500-volt motor. The cupola is blown by an Alldays fan, 3,000 cub. ft., 21 in. w.g., driven by a 20-h.p. motor. The foundry floor is provided with a casting pit 12 ft. square. Two moulding machines by the Pneumatic Engineering Appliances Company are in service. The core stoves and annealing furnaces are coke-fired and charged with bogies.

Metal is brought down in the ironfoundry in two Thwaites cupolas of 6 tons and 4 tons per hour

Fig. 4.—Erecting Bay; Powell Duffryn Works.

capacity respectively. They are served by a Thwaites 15-cwt. electric hoist. The charging platform, as also that for the steel plant, is covered by a lean-to 102 ft. × 16 ft. Blast for the cupolas is furnished by a Sulzer fan driven by a 20-h.p. motor, a similar fan acting as a standby. The three core stoves—a fourth is being built —are coke-fired. The machines installed include five by the Pneumatic Engineering Appliances Company, a MacDonald, a Britannia (Coventry) hand squeezer, and two Whittaker wheel machines to mould wheels up to 20 ft. in dia., the whole of the machines being served with pneumatic riddles. Fettling is done in the centre of the shop. In addition to the usual grinders, there is a battery of tumbling barrels driven by an 18-h.p. B.T.-H. motor, a Hill cold saw for cutting off risers, and a full complement of pneumatic tools.

The brassfoundry, which is in tandem with the ironfoundry, contains a Monometer furnace of 300 lbs. capacity and a 600-lb. Morgan furnace.

The machine bay, served by a 5-ton Royce crane, contains some very fine tools, amongst which mention may be made of a number of lathes by Scott Brothers, with centres up to 14 in. and beds up to 30 ft.; a 4-ft. face-plate lathe by the same makers; together with Dickinson, and Noble and Lund lathes, two Kearns universal milling machines, two Butler vertical boring and turning mills, a Butler and two Asquith radial drills, planers by Butler and Alfred Herbert, three Selson shapers,

a Holroyd and a Cincinnati universal millers, three Lang lathes with patent drive, a Butler double-headed vertical turning and boring mill, a Jackson die-sinking machine, and a Giant key-seater. In the turret section of the shop is a Lang centreing machine, a group of Herbert hack-sawing machines, and eight Herbert turret lathes. At the end of the machine bay are the general stores and loading sidings.

The erecting bay is served by a 20-ton Broadbent crane. In the mid-position is the tool room, and above this the foreman's office and the progress offices. In this bay is a Lang 18-in. all-geared-head lathe with two saddles and 28-ft. bed. Going through the erecting shop at the time of our representative's visit were two double-drum and two single-drum haulages, all of these being of 150 h.p.

The forge bay is served by a 5-ton Royce crane. The forge plant comprises Massey hammers of 15 cwts., 10 cwts., and 5 cwts. respectively; two 30-cwt. and one 15-cwt. Bretts stamps, and 17 Keith-Blackman hearths. These last are all coupled up to a Keith-Blackman exhaust system, the fan being driven by a 25-h.p. Westinghouse motor. The fires are arranged in parallel lines, a blowing fan serving each line.

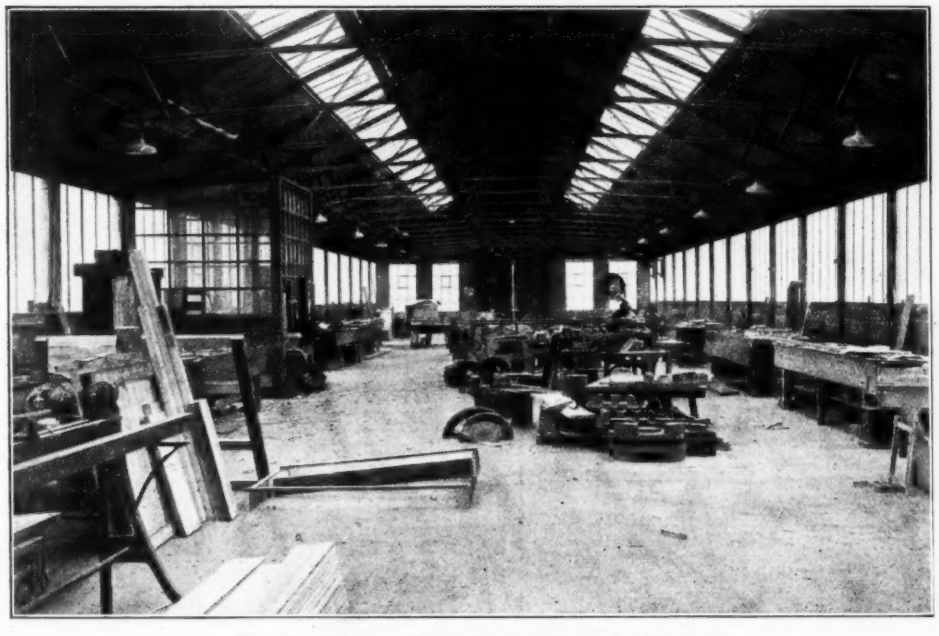


Fig. 5.—Pattern Shop; Powell Duffryn Works.

The constructional bay is served by a 10-ton Broadbent crane, the plant including a De Bergue cropping machine, a straightening and bending machine by the same maker, cold saws, etc. Some idea of the scope of this shop may be gathered from the fact that the decking arrangements for the pit-bottom at Derry, which was nearing completion, comprise approximately 220 tons of material.

The electricians' shop is contained in a separate building. For the time being it is not proposed to construct electrical machinery, and the present shop is devoted entirely to repair work.

The power house contains a Fullerton, Hodgart & Barclay compressor, driven by a 100-h.p. motor. Electrical energy is taken from the Company's mains at 3,000 volts, transformed to 500 volts and 220 volts for power and lighting respectively. The laboratory occupies the first floor of a separate building, the ground floor of which will be equipped for testing and experimental work generally.

R. & A. Main, Limited, Gothic Ironworks, Falkirk, have decided upon extensions to their moulding shop. The work is being carried out by the Glasgow Steel Roofing Company, Limited, North-Western Works, Possil Park, Glasgow.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Sound Castings, Runners and Risers.

To the Editor of The Foundry Trade Journal.

Sir,—On page 338 of your issue of April 26, in the report of the discussion on Mons. Ronceray's Paper, I notice a small misprint has occurred, by which I am quoted as referring to 50-ton moulds; this should read 5-ton moulds.

As I have no experience of this system of running with moulds of the larger size mentioned, I shall be glad if you will insert this in your next issue to prevent misunderstanding.—Yours, etc.,

Fred. P. Wilson.

Tees Ironworks, Middlesbrough.
April 27, 1923.

Physics of Cast Iron.

To the Editor of The Foundry Trade Journal.

Sir,—With reference to your footnote at the end of my reply on page 335 of this week's issue, if it is only your intention to recommend students reading for an examination to keep to the views expressed in the average text-book and to answer their examination questions accordingly, I am with you all the way. After that comes the deluge of practical experience during which the beginner would be well advised to clean the slate of theory for a time.

Admitted certain "definite compounds" *may* exist in cast iron, but particularly in the case of S., which you quote it cannot be *proved* how much exists as MnS, FeS, etc., for it is beyond doubt, especially in high S. irons—as malleable cast—that both these compounds may exist together, even though there be—according to "chemical arithmetic"—the necessary percentage of Mn to take up all the S. present.

With regard to Fe_3C, etc., it may be well to make use of an historic phrase "wait and see," for it is at present in the melting-pot.—Yours, etc.,

E. Adamson.

18, York Street, Sheffield.
April 28, 1923.

P.S.—By the way, through a printer's error, you have missed out the word "silicon" on page 333, second column, first para, lines 11 and 12, below the photograph of the fracture, which should read: "As shown above, *silicon* reduces the first arrest."

An Apprenticeship Course in Foundry Practice.—XLI.

By Ben Shaw and James Edgar.

RUNNERS, RISERS AND HEADS.

(*Continued from page* 343.)

Top and Bottom Pouring.

Much difference of opinion exists as to whether a mould should receive metal at the top or bottom. Each have their special advantages or disadvantages, according to the nature of the work and the kind of metal to be cast. It is generally advisable to introduce the metal as quietly as possible, and this can best be effected by bottom pouring. Particularly is this so with aluminium, because a film of oxide is formed on the surface in contact with the air, which increases in quantity and is distributed throughout the mould when it is agitated at the time of pouring. In this case top pouring is not so good as bottom pouring. It is, however, necessary to bear in mind that the mould must be filled, and, when the work is intricate and thin in section, the metal must be hot enough to maintain its fluidity while it rises in the mould. The metal gradually gives off its heat as it rises in the mould, and consequently cold shuts are more likely to result from bottom pouring. In large moulds dross is collected, which rises with the metal and is likely to lodge against projecting parts of the mould or be trapped against cores. In many cases, when bottom pouring is adopted, the metal is allowed to wash against the bottom of the mould, and the resulting casting is frequently scabbed owing to the cutting action on the mould surface. Apart from interfering with the clean skin on the casting, the scab in itself does not necessarily condemn the casting, but the sand cut away is carried with the metal, which increases the dross, and, incidentally, the likelihood of more being trapped in the casting. As a rule, when bottom pouring is desirable, it is better to introduce the metal in the manner shown in Fig. 11. This effectively distributes the metal and reduces cutting action.

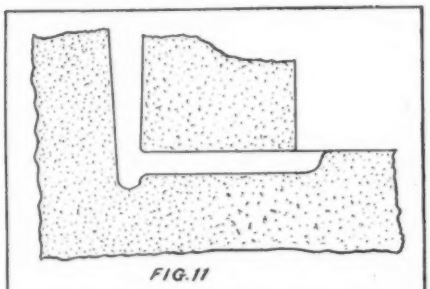


FIG. 11

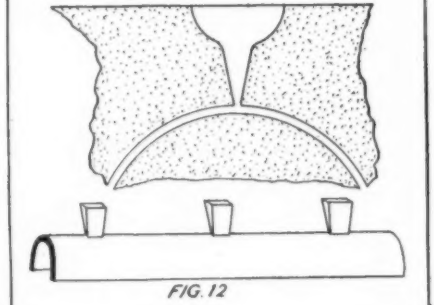


FIG. 12

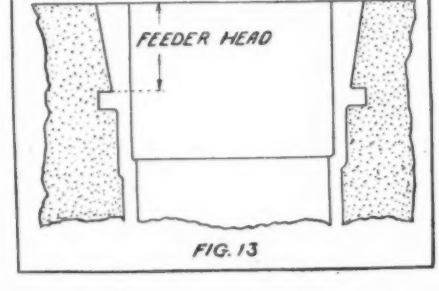


FIG. 13

When the mould is filled from the top, it is necessary so to place the runners that the metal does not strike projections in the mould nor impinge against the mould or core with such force as to produce a cutting action. This should be guarded against, especially when the metal enters direct from the downgates. Direct pouring is employed when the casting is very thin in section, and it is desirable to have very hot metal at the top to maintain its flow and keep it active. In some forms of thin work, such as baths, guttering, etc., a special form of wedge or plumb-gate is used, as shown in Fig. 12, in order that the metal will be distributed rapidly. In addition to maintaining fluid metal on the surface as it rises in the mould, many prefer running at the top because the surface metal is kept in a continual state of agitation, which reduces the possibility of dross lodging against the mould. Thus, many prefer this form of running because the dross is more likely to rise with the metal to a head or rise clear of the required casting. Its chief advantage, however, is in supplying hot metal at the top; the metal then maintains its fluidity, in which state it is better able to fill the mould completely, and trapped gases are more likely to escape.

Difficulties with this latter method result from the drop given to the metal when first entering the mould. This is not only likely to cut the mould but causes the metal to splash, and the small parts are rapidly chilled in the cool mould, forming what are known as shot. These frequently lodge at some part of the casting that is required to be machined, and the hard spots that are formed give trouble to the machinist. When top pouring is resorted to, it is necessary to place the runners so that the metal will fall clear of intervening parts of the cores or mould; otherwise the force of impact is likely to break the mould. When this occurs, the casting is invariably a waster. In some cases, when the design of the work prevents the use of runners to the sides, bottom running is advisable, as, with direct top running, the splashes caused at the outset may damage the mould to such an extent that the resulting casting is condemned. This introduces the necessity for some form of worm or horn runner to supply metal quietly from the bottom.

For such work a combination of top and bottom running is preferable. The advantages of each method can then be effectively utilised. Thus, metal can be introduced at the bottom and top running commenced only after sufficient metal has entered the mould to render the possibility of damage being done very remote. Bottom running may be used so that the metal will form a cushion for that which is subsequently top run. The use of both methods in combination assists very materially in keeping the metal at a regular temperature, and, while this reduces the advantages of top running from the point of view of feeding, facilities can be made whereby only a limited amount of metal is allowed to enter at the bottom, the remainder of the mould being filled from the top.

Quick and Slow Running.

The experimental work of Mons. Ronceray has focussed considerable attention on the possibilities of slow pouring by means of pencil gates. He has found that, in certain classes of work, by using very hot metal and reducing the area of entrance to the mould, clean castings can be produced possessing a similar density throughout, not only when the metal sections are comparatively thin, but when they are thick and with castings of unequal thickness. The method is not new, but its possibilities have undoubtedly been increased as a result of this experimental work. Both top and

bottom running seems to have given somewhat similar results as far as the regular density of the metal is concerned. The student is advised to refer to previous issues of this journal and read some of the results obtained by Mons. Ronceray. In our opinion the most interesting feature of the method is the homegeneity of the metal produced in the casting, there being little evidence of internal contraction. It seems evident that, when some moulds are filled slowly, the metal introduced passes through various stages towards solidification, during which time liquid shrinkage takes place and the supply of hot metal really feeds that metal already in the mould. When a mould is filled quickly and the metal sections are thick, a skin or shell of solidified metal is formed in contact with the mould enclosing fluid metal; the heat is gradually extracted by the mould and cores, and the centre of the metal thickness is the last to solidify. The rapid solidification of the outer shell in comparison with the inner metal influences the texture. This can easily be proved by an examination of the scrap heap. If a heavy section be examined, the outer part of the fracture will show the texture to be open at the centre, but gradually increasing in density towards the skin of the casting.

The speed of filling a mould, however, must be governed by the design of the casting to be made. It must be completely filled, and fast enough to prevent the possibility of cold shuts. Slow filling must be watched carefully in green-sand work, particularly when the surface area of the cope is large, because the comparatively weak sand is then influenced more by the intense heat from the metal, and parts may collapse or the cope may be drawn before the mould has been completely filled. Metal gives off its heat more quickly in green-sand moulds than in either dry-sand or loam moulds, and consequently the area of runners suitable for running a dry-sand mould would probably cause a short run if used for a similar job in green sand.

When a mould is filled too quickly, it is subject to increased pressure, and may be strained in consequence, and the disturbance might be sufficient to make the resulting casting a waster.

Quick running of a job reduces the time during which gases and air can more readily escape, and, unless special venting facilities are made to suit rapid pouring, the job is likely to blow, and this invariably means a bad casting.

The speed at which a mould should be filled depends very much on the complicated nature of the casting required, its sectional thicknesses and the kind and temperature of the metal to be cast. The most important requirement is that the runners should be large enough to ensure that the mould will be completely filled, and, making due allowance for the fluidity of the metal to be cast. Moulds for thin work should be run quickly and with hot metal, in comparison with those for thicker work, which can be filled slower and the metal need not be quite so hot.

Risers.

There is much difference of opinion amongst moulders whether risers should be open or closed at the time of pouring. This applies also to feeder heads. This will be best understood if we consider the conditions when casting. The air in the mould expands with the rise in temperature, and, together with other gases formed at the high temperature, make a rapid escape through the riser. This tends to counteract the influence of venting at other parts of the mould, and tends to induce air and gases that should escape from the sides and bottom to pass through the riser. Thus, an open riser may cause the casting to be scabbed. Again, the rush of gases may disturb the cope near the riser, when it is open, or the release of pressure may cause the cope to be drawn, either due to the air in the cope being induced by the rapid exit from the mould or to the sand being comparatively weak. By closing the riser it acts more in the form of a safety valve, and additional pressure is exerted on the cover and sides of the mould, which increases the effectiveness of other vents and, incidentally, supplies that pressure which is more likely to prevent the cope drawing. Green-sand moulds are more subject to bad results from open risers than either dry-sand or loam moulds.

Risers should be placed at the highest points of a mould or at the highest part of subsidiary parts of the mould, in order that air or gases will be released at these places. In many cases, what is known as a needle vent is sufficient to prevent air being trapped. These differ from ordinary vents in that the opening, though small, is direct from the mould and similar to a riser.

Feeding Heads.

This expression is used to cover any gate or riser so placed that metal contained in it is likely to make good the deficiency of metal in the casting near to it due to shrinkage. This term is applied whether the casting is actually fed by hand or not. The feeder head, therefore, provides a reservoir of liquid metal from which the casting proper may draw to make up for shrinkage losses. Much difference of opinion exists respecting the value of feeder heads, but there is no doubt that many jobs are more successfully cast with heads than without, and this applies particularly to the casting of steel and bronze. When the bulk of metal is considerable, or when the casting consists of both thick and thin sections, some form of feeder is necessary. In some cases it is undoubtedly possible to dispense with feeders by means of slow running, but when the casting varies considerably in its sectional thickness, the metal must be run to suit the thinnest section, and the metal will either be too hot or too quickly poured for the thick sections; therefore, unless some means are adopted to cause the thicker sections to give off their heat rapidly, the thick parts will draw. Denseners and chills are almost indispensable to extract the heat from thicker parts of a casting in order that it will solidify more nearly at one time. When their use is not possible or practicable, then some form of feeder is necessary.

When the casting is not to be fed by hand, the head should be thicker than the metal thickness of the casting on which it is used, or gradually increasing in thickness from the metal thickness. The metal in the head can only be useful for feeding purposes when it is the last to solidify. Heads are sometimes used that solidify before the casting. These are worse than useless, as they draw from the casting.

Feeder heads are frequently used on cylindrical work, especially when the castings are to withstand high pressure. A cylinder liner is such a type of casting upon which it is customary to cast a head. The height and particular shape of the additional metal varies considerably in different foundries, but a common form is shown in Fig. 13. The metal thickness is graduated to minimise the strain in the casting, and at the same time to give a substantial body of metal as a head. These castings are usually run at the top, and thus the head receives the hottest metal and will be the last to solidify.

When the head is smaller than the part of the casting it is expected to feed, a practice frequently adopted to reduce the expense of cutting the heads from the finished casting, some form of hand feeding is often useful. Feeding by hand is done with rod iron, either $\frac{3}{8}$ in, $\frac{1}{2}$ in. or $\frac{5}{8}$ in., according to the size of the head. The main idea of feeding is to keep the head open, and hot metal can be added with advantage to assist the feeding. This is especially necessary when the heads are smaller than the metal thickness of the casting; otherwise the head will solidify first. Considerable care is necessary to feed a casting successfully. The rod should not penetrate far into the casting proper, and the vertical motion should be regular. The rod should be heated before it is used to reduce the chilling effect on the head metal, and other rods should be ready for use when new metal is introduced. It is important to remember that the metal should have sufficient life in it to flow when the rod is taken out. It is better not to feed at all than to feed too long.

The use of large feeders on castings add considerably to the expenses of fettling and machining. Possibly in the future all castings may be made successfully without the aid of risers and feeder heads, but that time is not yet.

XUM

Modern Brass Foundry Alloys.*

By Francis W. Rowe, A.M.I.Brit.F.

Tin and Phosphor Bronzes.

This class of bronze is one of the most widely used of brass-foundry alloys, and is perhaps more influenced by variations in methods of treatment (i.e., casting temperature, rate of cooling, etc.) than any other alloy. Pure copper-tin alloys are seldom made nowadays. Phosphorus is, or ought

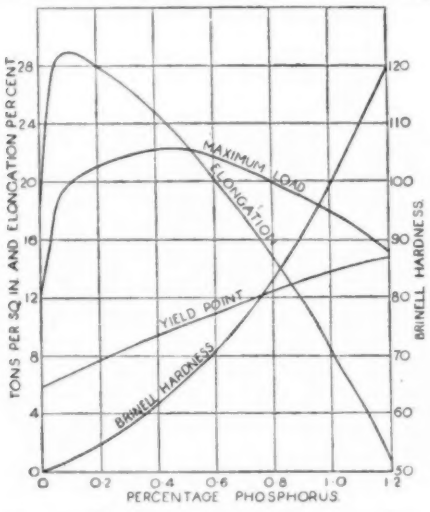


Fig. 1.—Mechanical Properties of Cast Phosphor Bronze (10 per cent. Tin).

to be, always added, if only in small quantities to serve as a deoxidant.

Fig. 1 shows the effect of increasing proportions of phosphorus on the physical properties of a bronze containing 90 per cent. copper and 10 per cent. tin. It will be seen that the first smallest additions of phosphorus cause a remarkable increase in the tensile strength and elongation of the alloy. It may also be said that it is practi

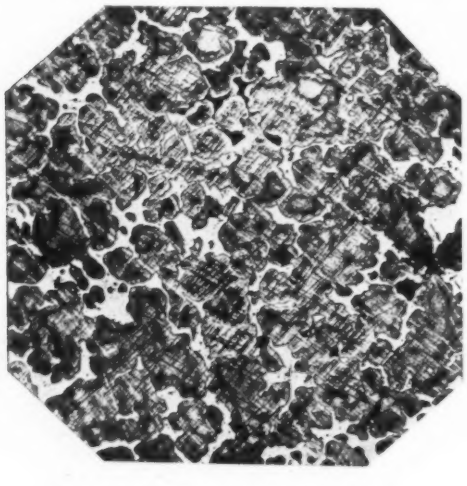


Fig. 2.—Phoshor Bronze at 100 dias.

cally impossible to produce perfectly sound castings regularly and consistently in this alloy without the addition of phosphorus.

The softest and most ductile of phosphor bronzes are those which contain the least amount of phosphorus: that is, those alloys to which phosphorus has been added only in sufficient quantity to remove the harmful and embrittling cuprous oxide.

With increasing proportions of phosphorus the alloy hardens progressively whilst the tensile strength is raised and the ductility lowered. The maximum tensile strength of 22 to 24 tons per sq. in. is reached when the phosphorus is in the neighbourhood of 0.45 to 0.55 per cent. With further increases of phosphorus the tensile strength falls whilst the hardness is raised.

The alloys with 1 per cent. phosphorus are used where the highest durability and resistance to abrasion are required, that is, for parts such as gear wheels and pinions, hard bearing blocks and bushes, etc. For work of this character however, the tin is generally raised above 10 per cent.,

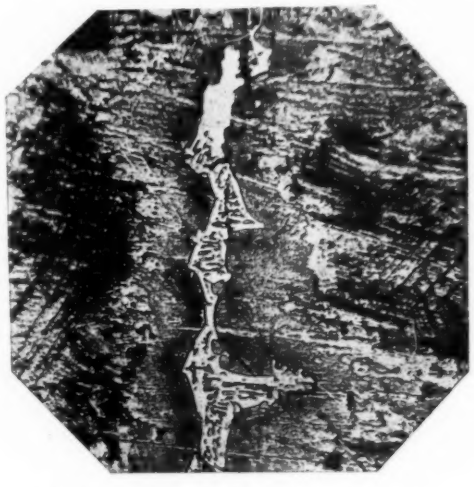


Fig. 3.—Delta Constituent at 800 dias.

often as high as 14 or 15 per cent., as, although it is cheaper to raise the hardness by means of phosphorus, when this element rises above 1 per cent. the alloy becomes very difficult to cast, being very liable to blow holes.

Fig. 2 shows the general structure of phosphor bronze under a magnification of 100 dias. The hardness of phosphor bronze and its value as a bearing metal is due to two causes: (1) The hard, white, brittle copper-tin compound seen in the micro-photograph, which is thrown out of solution

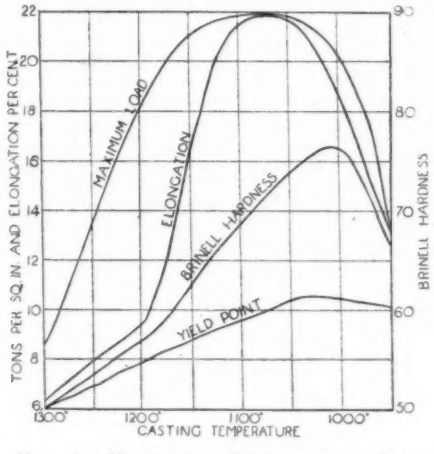


Fig. 4.—Mechanical Properties of Green Sand Cast 1¼ dia. Phosphor Bronze.

in greater quantity when phosphorus is present: (2) the hard, dove-grey copper-phosphide which is present with the copper-tin compound.

Hardness of Phosphor Bronze Constituents.

The comparative hardness (not, by the way, in Brinell figures) of the various constituents of phosphor-bronze, are: Pure copper, 78; copper-tin solid solution, 90 to 110; copper-tin compound (delta crystals), 750; copper phosphide Cu^3P), 267; and tin oxide crystals, 5,390.

* A Paper presented before the Lancashire Branch of the Institution of British Foundrymen, April 11, 1923, Mr. J. Haigh presiding.

As a matter of interest it may be stated that crystals of tin-oxide, such as are found in a burnt bronze, are considerably harder than any other metallic crystal (including martensite in a fully-hardened steel).

Thus from this it is easily deduced that a burnt bronze (which contains such crystals) would be fatal as a bearing—a fact which has long been known in practice although the theoretical reason is only a recent discovery.

Reverting to Fig. 2, this shows the dark matrix of the copper-tin solid solution with the white copper-tin compound intermingled with copper phosphide.

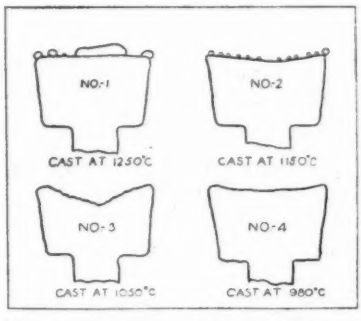


FIG. 5.—SKETCH OF RUNNER HEAD OF PHOSPHOR BRONZE CAST AT VARYING TEMPERATURES.

Fig. 3 shows this copper-tin compound known as the delta constituent under a magnification of 800 dia. This combination of hard particles with a soft matrix is the essential requirement for all bearing metals. The hard particles support the load and take the wear, whilst the soft matrix allows the bearing to adjust itself to inequalities in the journal. Also the soft matrix wears away much more rapidly than the delta constituent, and thus leaves pockets for the lubricant.

The addition of lead, which is often made to phosphor bronzes for bearing purposes, acts in the same way as the matrix, only in a more marked manner. The most generally used mixing for leaded bearing alloys of this character is: Copper, 82; lead, 8; tin, 9; and phosphorus, 1 per cent.

Whilst touching on the subject of bearings, it should be mentioned that zinc is extremely detrimental to a phosphor bronze for bearing purposes. The addition of zinc materially hardens the soft matrix, with the result that the bearing wears a great deal faster in service.

Effect of Casting Temperature on Phosphor Bronze.

The effect of casting temperature on the physical properties of a sand-cast phosphor bronze is shown in Fig. 4. These curves have been plotted from the averages of a great many test bars made in the foundry under working conditions. It will be seen that the tensile strength varies from 8 to 24 tons per sq. in., with a difference in casting temperature of 250 deg. C., and the elongation varies from 4 to 28 per cent.

Starting with a casting temperature of 1,300 deg. C., the tensile strength and elongation rise until the maximum values are obtained in the neighbourhood of 1,040 deg. C. After this temperature is passed all the good properties rapidly fall away, and below 1,000 deg. C. casting becomes very nearly impossible.

Thus the golden rule for phosphor bronze is to cast at the lowest temperature which will successfully run the job, although it must be admitted that in a great many cases this is higher than will give the maximum physical properties. From these curves it will be deduced that phosphor bronze is not suitable for light work on account of the low casting temperature necessary to give good physical properties—a point which will be more clearly emphasised later on.

Fig. 5 shows some diagrammatic sketches of runner heads of phosphor bronze. These are made from a great many observations of various casting temperatures, and form a good guide as to whether a casting has been poured at the correct temperature. No. 1 represents the head from a casting poured at 1,250 deg. C. The head has a flat or only slightly sunken top, which is partially covered with "tin sweat." This exudation takes place in all phosphor bronzes which are cast too hot. The bright white beads start to appear about two minutes after the casting has been poured. For obvious reasons they only appear on the runner. As the casting temperature falls, these beads decrease in size and number, and at the correct temperature the head is well sunk and presents a well-pimpled surface but no beads. Below this temperature the top again becomes flat, due to the majority of the shrinkage taking place outside the mould, but as would be expected, no beads are present. Most foundrymen display curiosity regarding the composition of "tin sweat," and a selection of typical analyses are given in Table I.

TABLE I.—*Analysis of alloy exuded from Phosphor-Bronze Heads.*

Test No.	Reference.	Cu.	Sn.	Pb.	Zn.	Fe.	P.
1	Casting ..	89.78	9.59	0.04	0.09	0.03	0.40
1a*	"Tin Sweat"	81.78	10.30	0.03	0.13	0.04	0.78
2	Casting ..	86.77	11.17	0.36	0.66	0.33	0.51
2a	"Tin Sweat"	78.40	18.91	1.32	0.10	0.14	0.90
3	Casting ..	85.89	12.21	0.86	0.40	0.31	0 13
3a	"Tin Sweat"	76.98	19.86	2.18	0.39	0.14	0.27

* Melting point of exuded portion was 620 degrees C

The actual composition varies with the analysis of the metal used, but ranges between 17 and 22 per cent. tin and phosphorus 0.3 to 1.3 per cent., with the alloys commonly made. The analysis of the metal used is placed alongside for comparison purposes. One of the interesting facts about these exudations is that they contain a much higher lead-content than the original alloy (where this element is present), which of course is to be expected. The cause of their formation is fairly obvious. They represent that portion of the alloy which is last to solidify and is squeezed out by the contraction of the solid portion.

Fig. 6 is a photomicrograph at 100 dia. of one of these exudations, which will be seen to consist largely of delta crystals. The strength of phosphor bronze is greatly influenced by the size of the section.

Fig. 7 shows the maximum strength obtainable in green-sand moulds with various sections. These figures would be better for dry-sand moulds, in which, of course, phosphor bronze should always be cast, on account of the lower casting tempera-

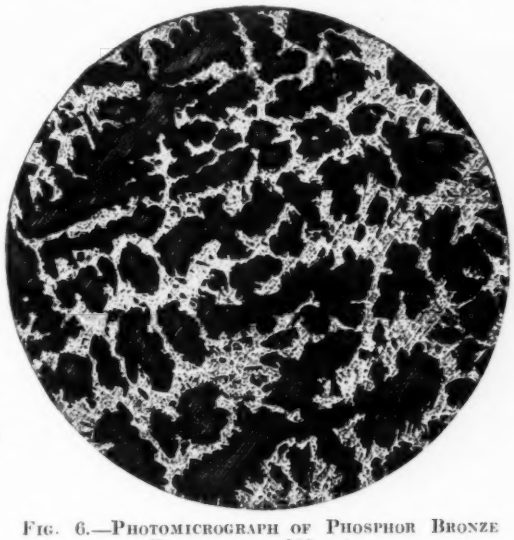


FIG. 6.—PHOTOMICROGRAPH OF PHOSPHOR BRONZE EXUDATIONS.—100 DIAS.

ture it is possible to employ, and the cutting action of the metal on the sand. These curves are compiled from records of many results and represent the best strengths that may be expected in castings of such sections made under normal conditions. Thus phosphor bronze is strongest and toughest when cast in heavy sections. Regarding the manufacture, very little need be said. The copper should be melted rapidly with a good layer of charcoal over it. On drawing the pot, a small

quantity of the phosphor-tin or phosphor-copper should be added and the metal well stirred with a graphite stirrer and skimmed. The rest of the phosphor-tin, block-tin, or phosphor-copper should then be added and the metal cooled to casting temperature, skimmed again and poured.

Gunmetals.

The term "gunmetals" covers alloys of copper, tin and zinc, with not more than 10 per cent. of the last two metals. Perhaps the best known and most widely used is the Admiralty mixture, 88—10—2. This metal is very popular with engineers as it has very good all-round properties,

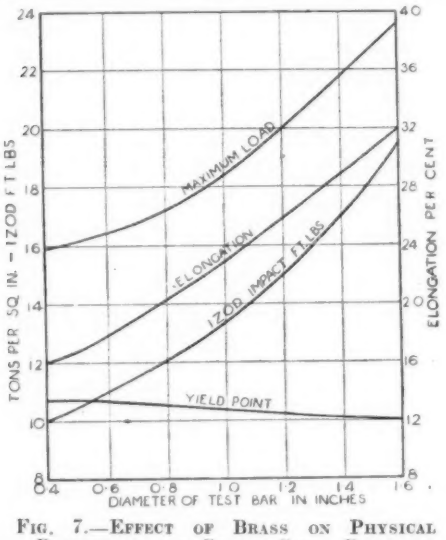


Fig. 7.—Effect of Brass on Physical Properties of Green Sand Phosphor Bronze.

though perhaps no one great outstanding feature. It possesses reasonable hardness, good durability, fairly good strength and resistance to fracture by shock, and a fair degree of resistance to corrosion. There have been a great number of papers presented to scientific societies within recent years regarding the effect of impurities on the strength of Admiralty gunmetal, and a large amount of controversy. The outcome of it all seems to be that the impurities arsenic and antimony, when present in quantities likely to be met with by a brassfounder using metal from a reputable source of supply, are nearly negligible, or, at any rate, not comparable with the effects which can be produced by maltreatment of the metal.

Lead in quantities up to 0.5 per cent. exercises no detrimental effect on the strength, but in fact is considered beneficial by some. This is rather a useful thing, as in general brassfoundry work (where a fair proportion of scrap must necessarily be used) it is difficult to keep the lead content below 0.3 per cent. There is rather a difference of opinion regarding the best casting temperature of Admiralty gunmetal. Carpenter and Elam published a paper some years ago in which a casting between 1,200 and 1,240 deg. C. was recommended, but their opinion was not backed up by physical tests and so loses a great deal of weight. Most brass founders consider this temperature too high, and prefer to run their lightest work about 1,180 to 1,200 and heavier work at 1,150 to 1,170 deg. C. For extremely high pressures, that is to pass a hydraulic test of 6,000 lbs. per sq. in., the Admiralty specify 86 per cent. Cu, 13 per cent. Sn, 1 per cent. Zn, and free from Pb. It must be capable of giving 14 tons per sq. in. in tensile, with a 3.5 per cent. elongation on 2 in.

This mixture is rather more difficult to obtain sound castings from than A.G.M., a typical analysis of which showed Cu, 87.6; Sn, 10.1; Pb, 0.21; and Zn, 1.97 per cent., and gave 20.36 tons per sq. in. maximum stress, 10.21 tons yield point, 15 per cent. elongation, and 16.5 per cent. reduction of area. The hydraulic mixture is not looked upon with any great favour by brass founders. It gives fairly good results, however, if great care is taken and melting and moulding conditions well defined. A point that is often forgotten is that the zinc should be added and well stirred in before the tin is added. The Admiralty mixtures are not much used by private concerns for pressure work, and much better results are obtained for this class of casting with additions of lead.

A leaded gunmetal alloy for steam valves for medium pressures, which contains 86.0 per cent. Cu, 8 per cent. Sn, 2 per cent. Pb, 4 per cent. Zn, and a trace of P, has given very excellent results over a long period. Castings made from this metal and tested to 2,000-lbs. water pressure have shown less than 4 per cent. total rejections from all causes over a number of years.

However, a softer metal made up of 81.35 per cent. Cu, 3 per cent. Sn, 8 per cent. Pb, 7.75 per cent. Zn, and 0.015 per cent. P, gives better pressure results but is not so good mechanically as the previous analysis. The casting temperature for sections $\frac{1}{2}$ to 1 in. thick should be from 1,090 to 1,110 deg. C. *A propos* of castings for pressure work, it may be said that casting temperature is one of the vital points. Gating is also another. In many types of castings there is one place, and only one, to run the job, and careful and logical experimenting is often needed before this is found. The quality of the sand is also extremely important. For this work only the most open sands must be used, and no close clayey sands (such as the Mansfield type) mixed with them.

No blacking or sleeking should be permitted; that is, nothing which will impair the free venting qualities of the mould. Scum gates should be used extensively, and if the pour of a casting is broken it will be fatal for high-pressure work.

Brasses.

By brasses one infers alloys of copper and zinc and containing only small amounts of other materials, which are usually present as impurities. The brasses are generally divided into three main classes, the best known of which is the ordinary or red brass. This, to most people, implies a doubtful sort of material, and they are very often right. It is usually made from the dregs of the scrap merchant's brass pile, together with as much pig lead as the metal can possibly carry. Ordinary brass of that character does not call for any consideration from a metallurgical standpoint, save to point out that a liberal dose of sulphur, preferably in the form of sulphide, will enable one to get more lead in than might be thought to be possible, and that cork floors in the fettling shop are a decided advantage when making this type of casting.

Unfortunately this type of casting has recoiled badly on the brass founder in that most engineers

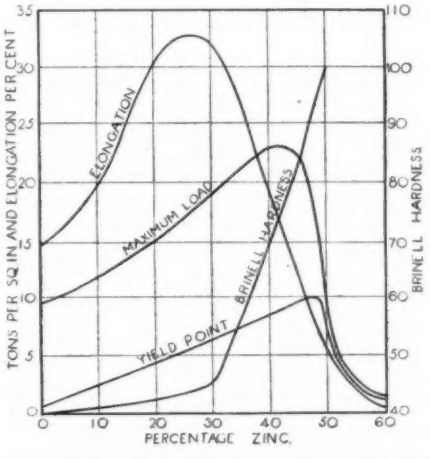


Fig. 8.—Physical Properties of Sand-Cast Brasses.

have a decided aversion to brass castings, and consequently a very useful series of alloys is not taken advantage of as much as they might be. In these days of fabulous tin prices it behoves brass founders to examine very closely the properties of alloys in which this element does not appear, as it is only by an extremely conservative use of this metal that the price can be brought down to reasonable levels. There is no doubt that a great

deal of the vaunted superiority of the bronzes is due to tradition and superstition mainly of the engineer.

Fig. 8 shows the physical properties which may be expected from sand-cast brasses when made from good material and with careful supervision. It will be seen that the yield point is very low until 30 per cent. zinc is exceeded. This, of course, means a material which is soft, fairly easily deformed, and very ductile. The extensive use of brasses with less than 30 per cent. zinc is hardly to be recommended for work of any importance, but the brasses with from 30 to 40 per cent. zinc have many excellent properties. Their limitations need, of course, to be well known. They are rather poor in their resistance to abrasion; in other words, they are not suitable for parts subject to heavy wear, nor are they fitted for parts subject to corrosive influences nor for pressure work. On other points they are equal, if not superior, to the bronzes. The attributes dear to the heart of the foundryman are that they are cheap and cast easily. As will be seen from the graph, they have good mechanical properties. The 60-40 cast-alloy has a yield of 7.5 tons per sq. in., and a tensile strength of 20 to 22 tons per sq. in., with an elongation of 15 to 20 per cent. By the substitution of 1 to 2 per cent. tin for 1 per cent. of zinc, the yield may be raised to 10 tons per sq. in., with a corresponding drop in elongation and an increase in hardness.

Chart 1 shows a recent page from the author's firm's test-book, giving figures for bars cast from one of these alloys with the ordinary routine of work.

PARK WORKS, MANCHESTER,
1784—*Naval Brass Castings for G.M.* 388/39.

March 20, 1923.

Mark. Description.	Original Sizes.		Yield Point.	Maximum Load.	Elongation.	Contraction of area.	Hardness.	Analysis.	
	Diam.	Area.	Tons per sq. inch.	Tons per sq. in. of orig area	On 2 ins. Per cent.	Per cent.	Brinell No.		
38 –1 ¾ in. dia. Bar	0.564	0.250	8.96	20.08	16	15.20	62	Copper	62.36 per cent
38 –3 „ „	0.564	0.250	8.88	19.44	19	19.40	60	Tin	1.71 „
388–7 „ „	0.564	0.250	9.12	21.20	20	19.60	65	Lead	0.17 „
388-11 „ „	0.564	0.250	9.32	20.40	18	20.80	67	Zinc	35.58 „
								Iron	0.06 „
								Phosphorus	nil „

CHART 1.—PAGE FROM THE TEST BOOK OF MESSRS. MATHER & PLATTS' RESEARCH LABORATORY.

Manganese Bronzes.

Manganese bronzes, or, to give them their correct name, high-tension brasses, are a very useful class of alloy but require considerable experience and a great deal of care to make successfully. They consist of high zinc brasses to which various other elements have been added. The other metals employed vary with different makers. The chief elements used for additions are manganese, tin, aluminium, nickel and iron.

Typical manganese bronzes show the following analysis:—

High Grade.—Cu, 55.09; Zn, 38.17; Sn, trace; Pb, nil; Fe, 0.80; Mn, 3.45; and Al, 2.40 per cent. The following physical tests will be associated with such: Yield point, 21 tons per sq. in.; maximum stress, 46.0 tons per sq. in.; elongation on 2 in., 26.5 per cent.; and reduction of area, 28.8 per cent.

Medium Grade.—Cu, 57.96; Zn, 38.32; Sn, 1.20; Pb, 0.63; Fe, 0.97; and Mn., 0.53 per cent.; and Al, trace. In this case a maximum stress of 39.5 tons, a yield point at 18.5 tons per sq. in., an elongation of 21 per cent., and a reduction of area of 21.8 per cent. can be considered as typical.

The high-grade alloy is made from all new material and no lead is permissible. The hardening elements are ferro-manganese and aluminium. The medium grade contains not exceeding 0.70 per cent. lead, and thus a certain proportion of scrap is allowed. Tin and ferro-manganese are used as hardeners. The physical tests (which are on bars machined from actual castings) are very much superior to the corresponding 60-40 brasses. High-tension brasses have a much higher shrinkage than yellow brasses, and thus casting difficulties are enormously increased. Every care is also needed regarding composition, as often little latitude is permissible. The analyses and physical tests given do not of course represent finality, but are those which have been developed to suit certain classes of work, and should only be regarded as typical.

Aluminium Bronze.

Aluminium bronzes such as can be used in foundry work vary from 6 to 11 per cent. aluminium. An alloy made to Air Board specification gave 86.44 Cu, 9.31 Al, 4.48 Fe, and 0.128 per cent. Si. This material gave 37.3 tons per sq. in. maximum stress, 14.4 tons yield point, 22 per cent. elongation on 2 in., and 26.8 per cent. reduction of area. The Brinell hardness number was 196.

Fig. 9 shows the variations of physical properties of sand-cast alloys with different percentages of aluminium.

It will be seen that the yield point of alloys below 5 per cent. aluminium is low, but after 6 per cent. is reached this rises fairly sharply, as also does the tensile strength. After 10 per cent. is passed the alloys become very hard and brittle and useless for commercial purposes. Usually in practice 3 to 4 per cent. of iron and some manganese is added to these alloys—a proceeding which materially raises the yield point and rather lessens the casting difficulties.

The great casting difficulties of aluminium bronzes will always militate against their extensive use. At the time of their introduction no alloys showed greater promise and yet fewer have been as disappointing. The alloys have a high shrinkage, but the outstanding difficulty is that of oxide formation. As every brass founder knows, it is impossible to obtain a clear surface on a pot of metal containing even traces of aluminium. Immediately a fresh surface is exposed to the air the tenacious oxide forms. Two streams of aluminium bronze will never unite perfectly, a fact that should be remembered in gating work for this alloy. Anything which causes this metal to be churned and mixed up after it has entered the mould is fatal to good castings. The metal should be fed in quietly and slowly, arranging that the scum (which is inevitably formed) is driven up an ample riser.

The Air Board alloy detailed above casts fairly easily, and not much trouble need be feared except in castings for pressure work.

Nickel Alloys.

Alloys containing nickel offer, perhaps, one of the most promising fields for investigation in non-ferrous work. There are, of course, several high-nickel alloys, which are at present made for special purposes, the properties of which are farly well known, but the possibilities of low-nickel alloys, *i.e.*, up to 15 per cent. nickel have by no means been fully exploited.

One of the best known of nickel alloys is Monel metal, a "natural" alloy in so much that it is made directly from the reduction of the matte produced by smelting a sulphide ore found in large quantities in Canada. A typical composition of the sand-cast material is: Cu, 28.63; Ni, 66.88; Fe, 3.26; and Mn, 1.02 per cent. On test this gave 27.6 tons M.S.: 12.7 tons Y.P.: 26 per cent. elongation, and 29.3 reduction of area. It has, of course, a high melting point, and is best melted for

casting purposes in the electric furnace. Its value lies in its good resistance to corrosion compared with ordinary bronzes, and it is now being fairly extensively exploited for parts subject to the action of corrosive alkaline liquors or those containing weak organic acids.

Foundry operations with Monel metal are attended with a great many difficulties owing to its high shrinkage, and on that account it has not proved very popular in this country, although it seems to be worked a great deal in the States.

Owing to the high price of tin many American firms are using alloys containing (1) Cu, 88; Sn, 5; Ni, 5; and Zn, 2 per cent.; and (2) Cu, 89; Sn, 4; Ni, 4; and Zn, 3 per cent. No. 1 will give 19.9 tons M.S.; 7.8 tons Y.P.; 34 per cent. E., and 33 per cent. R.A. The figures for No. 2 are 18.6, 6.7, 30 and 28 respectively. In these it will be noticed that there is nickel in place of the usual tin bronzes. The physical properties are very good, and the alloys casting well.

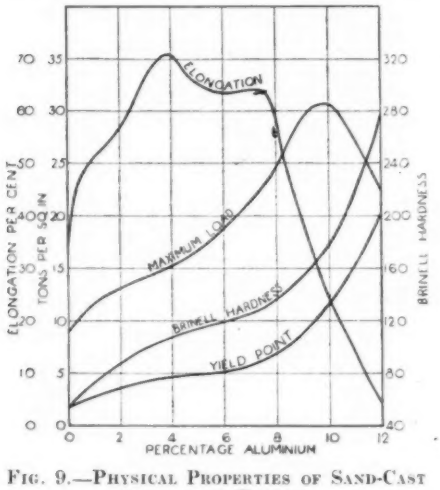


Fig. 9.—Physical Properties of Sand-Cast Aluminium Bronze.

Nickel alloys seem to offer the best field for alloys for corrosion resisting purposes. Most proprietary brands at present on the market for this class of work contain some proportion of nickel.

Copper Castings.

Nearly all foundrymen have been called upon at some time or other to produce pure copper castings of high electrical conductivity. As is fairly well known, it is impossible to obtain sound castings from pure copper without additions. Fig. 10 shows a 12-in. dia. × 1 in. thick plain ring cast for demonstration purposes from a charge of electrolytic copper without additions. Such holes as are seen are due to liberation of gas at the moment of solidification, and naturally appear on the top side of the casting.

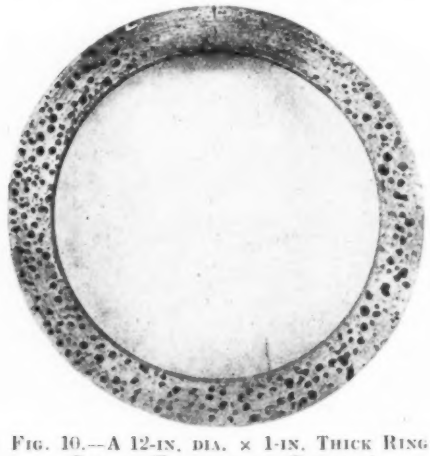


Fig. 10.—A 12-in. dia. × 1-in. Thick Ring Cast in Electrolytic Copper.

Consequently a deoxidant must be used which will remove the oxide from the copper, and yet not leave enough of itself in solution to affect materially the conductivity of the finished casting. Such well-known deoxidisers as zinc and phosphorus are inadmissible for this class of work, as they lower the conductivity in a very marked manner, even when present in the smallest quantities. Commercially the most economical material to use is silicon-copper, though other material give good results. The highest conductivity is, of course, obtained when the least amount of deoxidant is employed.

Table II. shows the effect of various deoxidants on the conductivity of the final castings. For plain work such as rings, as little as 0.2 per cent. of 10 per cent. silicon-copper can be used if care is exercised. For more complicated work it may be found necessary to use 0.75 or 1 per cent. of the 10 per cent. alloy.

Fig. 11.—A Microphotograph of Best Selected Copper at 100 dias.

As will be seen from the table the best results have been obtained by the writer from boron carbide, but this material is very expensive to use and results nearly as good can be obtained with silicon-copper. The charge of electrolytic copper should be melted as rapidly as possible (well covered with charcoal) and superheated to 1,300 deg. C., and the necessary amount of silicon-copper added 5 minutes before drawing the pot. The charge should be well stirred after drawing, and the castings poured about 1,200 deg. C. Needless to say, best selected copper (or any copper other than the highest grade electrolytic) is useless for this class of work.

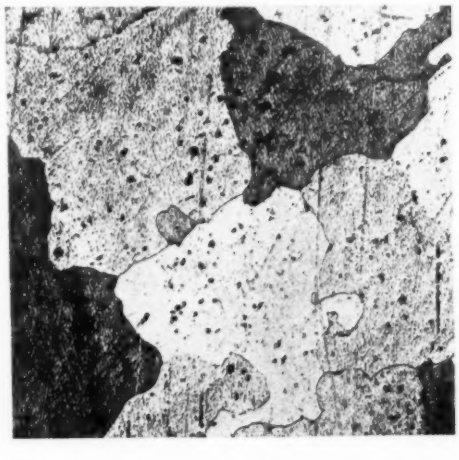


Fig. 12.—Shows a Section from a Copper Casting to which Silicon Copper has been Added.

Fig. 11 shows a microphotograph at a 100 dia. of a section of best selected copper polished but unetched. The copper oxide, in the form of a eutectic, is common to all coppers made by melting processes.

Fig. 12 shows a section from a casting made with 0.75 per cent. of 10 per cent. silicon-copper, when it will be seen that the network of oxide has disappeared, the dots present being silicide of copper.

Light Aluminium Alloys.

Pure aluminium is fairly extensively cast for chemical plant and cooking utensils. Owing to its softness and lack of strength it does not, however, find many applications in engineering practice. The aluminium alloys which are being most extensively used are confined to three or four.

The alloy that is used in this country more than any other for general purposes is the 2 L 5, which on analysis showed Al, 83.75; Zn, 13.5; and Cu, 2.75 per cent. The physical properties of the chill cast material were 11 tons tensile and 3 per cent. elongation, the Brinell hardness 70 and the specific gravity 3.0. The one disadvantage of this class of alloy is that it will not retain its strength at high temperatures, and for work of this character the 3 L 11 alloy is employed. This contains 93 per cent. Al and 7 per cent. Cu. Its chill cast properties are 9.0 tons tensile (minimum) and 3 per cent. elongation (minimum). The Brinell hardness number is 63 and the specific gravity 2.9.

For automobile pistons the L. 8 is almost exclusively used. This is a straight 12 per cent. copper alloy, and withstands 9 tons tensile. The Brinell hardness is 85 and the specific gravity 2.95. It retains its strength at high temperatures better than the 3 L. 11 alloy, but it is not so easy to obtain non-porous castings from it. To sum up briefly, therefore, the three alloys suitable for the ordinary foundry are:—(1) The L 5 alloy for crank-

TABLE II.—*Showing the Physical Properties of Cast Copper made from Electrolytic Cathode Copper 99.9 per cent pure.*

Deoxidant used.	Percentage deoxi	Percentage conductivity (copper 100).	Maximum stress (tons sq. in.)	Elongation 2 in.
9.6—Silicon copper	0.25	86	10.90	45
Do.	0.50	75	11.44	43
Do.	1.00	56	13.96	39
Boron Carbide ..	0.75	94	10.72	48
Magnesium metal	0.50	70	9.70	34

cases, gear-boxes and general work; (2) the L 11 for non-porous castings, *i.e.*, induction pipes, water jackets and radiator castings with or without high temperatures; and (3) the L 8 for pistons.

Finally, the important aluminium-silicon alloys, the best known of which is the "Wilmil" alloy, represent the latest and best advance made in recent years. These alloys are extremely fluid when molten, cast with great ease, and have excellent physical properties. It is quite possible to bend a casting double without fracturing it. It is entirely non-porous, and can be used for hydraulic work of the severest character. Lastly, the alloys possess good anti-corrosive properties. A typical analysis gave Al, 91.0; Si, 8.0; Cu, 0.5; and Mg, 0.5 per cent. On test it gave 15 tons tensile; 7.0 tons yield point, and 15 per cent. elongation. The Brinell hardness and specific gravity were 60 and 2.68 respectively.

Mention should also be made of the "Y" alloy (Al, 92.5; Cu, 4; Ni, 2; Mg, 1.5) developed at the N.P.L. This alloy undergoes a remarkable increase in strength on heat treating, the tensile strength increasing from 12.2 to 20.6 tons per sq. in., and the elongation from 2.5 to 7.8 per cent.

In conclusion the author desires to thank, for permission to publish this paper, the Directors of Messrs. Mather & Platt, Limited, and in particular their Director of Research, Dr. S. F. Barclay, from whose foundries a large portion of the data was obtained. He is also deeply indebted to Mr. George Mortimer, of Messrs. William Mills, Limited, for his up-to-date information regarding the light alloys.

Acieries de Sambre-et-Meuse.—This French concern will ask its shareholders to increase its present share capital of 4,000,000 fcs. by 2,000,000 fcs. by the issue of 4,000 new 500-fc. shares. The price of issue is not yet definitely fixed, but will probably be 1,500 or 1,600 fcs. per share.

A New Bronze Alloy.

The physical properties of a new alloy allied to bronze, known by the name of "Coronium," were dealt with at some length by MR. E. HALL CRAGGS, of the Brentford Foundry, Middlesex, in a Paper read before the Cleveland Institution of Engineers at Middlesbrough.

On the point of structure, the author remarked at the outset that, due to certain inherent difficulties in connection with the microphotography of the alloy, this branch of investigation had not been sufficiently advanced to give any account of it, but it might be observed that, with the present standard apparatus and etching solutions, no definite crystalline outlines had as yet been identified even when a powerful microscope had been employed, so wholly homogeneous was the condition of the alloy. As the process for its manufacture was the property of a limited company, he was not in a position to state precisely what the composition was, nor to give particulars of the manufacturing process, but for the purposes of his Paper it might be assumed that the composition of "Coronium" was as follows:—Copper, 16 parts; zinc, 3 parts; tin, 1 part. Covered in these figures were the usual impurities. The constituents given were combined to form a single solid solution.

With regard to physical properties, in ordinary sand castings of handy size, tensile tests had given 16 to 18 tons per square inch, according to conditions connected with each case. In some cases, where very special castings had been made and unusual precautions taken in the pouring and cooling, an ultimate tensile test of 22 tons to the square inch had been officially reported. In one of the cases last referred to, the elongation was officially given as 38 per cent. on 2 in., this having reference to the same test-piece, and at the same time there was a reduction of area observed of 37 per cent. The elastic ratio observed at the same time was 0.6, a figure of great importance. Referring again to the figure of from 16 to 18 tons per sq. in., engineers using the material for commercial purposes could safely rely upon an elongation taken on the same test-piece having a figure in excess of 25 per cent. in 2 in., with a reduction of area in excess of 25 per cent. at the same time. The Brinell hardness as cast might be taken under any circumstances at a figure of 85 to 90 on the Brinell scale, and the machineability—assuming good brass to be 80—might be taken at 100.

The metal could be rolled cold into sheet of the finest gauges, and drawn into rod or tubes and generally wrought with ease. The effect on the physical properties of rolling into rod was a good general example of the result of mechanical treatment, and the tests that had been made gave very interesting results. Test-pieces were taken from a bar rolled from the ingot to $\frac{5}{8}$ in. diameter, and the maximum tensile stress was proved to be over 35 tons per sq. in., with a corresponding elongation in 2 in. of 58 per cent. and a reduction of area of just over 60 per cent. The specific gravity in the cast state was 8.9, as compared with 8.8 as the maximum figure obtained in the heaviest phosphor bronze as cast. The melting point was 1,100 deg. C. (2,030 deg. Fah.). The strength and elastic limit were not seriously affected by annealing. Compared with phosphor bronze, the latent heat was greater, and the heat conductivity correspondingly rather less. The alloy had an electric resistance as great as that of nickel (whose resistance was materially higher than that of any copper alloy). The power of resistance to corrosion, so far as it had been possible to test the matter, seemed to be very high. The coefficient of expansion had not been finally determined, but observations up to date showed that it corresponded very closely to that of cast iron.

A MEETING of the South Wales Branch of the Institution of Mechanical Engineers was held in Swansea on April 10, when Mr. Frank Somers, of Walter Somers, Limited, Haywood Forge, Halesowen, near Birmingham, read a paper on "Methods and Tools Used in the Manufacture of Iron and Steel Forgings." Mr. D. E. Roberts, chairman of the branch, presided.

Institution of British Foundrymen.

BIRMINGHAM BRANCH.

The annual general meeting, held at the Municipal Technical School, Birmingham, on Saturday, April 14, was very well attended. Mr. W. J. Flavell, the retiring President, was in the chair.

Mr. D. Wilkinson (Secretary) presented a report on the activities of the past session, in which he stated that the attendance at the meetings averaged about 55. He thought the Branch might be congratulated upon having members sufficiently interested to turn up in the numbers he had mentioned during a period of severe trade depression. The state of trade and employment had effected the membership of the Branch to some extent.

The President thanked the officers and members for the support they had accorded to him during his year of office, and with regard to his successor in the presidency explained that Mr. A. Wardle, the senior Vice-President, could not see his way to become President during the coming session. In the circumstances Mr. J. B. Johnson, the junior Vice-President, had intimated his readiness to accept the office, and he assured the members that in Mr. Johnson they would have an efficient President. He concluded by nominating Mr. Johnson for the presidency for the coming session.

Mr. Matthews seconded the motion, which was carried.

Other officers were nominated as follows:—

Senior Vice-President, Mr. T. Vickers; junior Vice-President, Mr. D. H. Wood; Secretary, Mr. H. Roe; Council, Messrs. E. H. Tyson, A. Parsons, F. G. Starr, G. A. Vaughan, Kitchen, D. Wilkinson, F. C. Edwards, F. Dubberley, and W. H. Moore; Branch delegates to the General Council, Messrs. H. Field and W. J. Flavell; auditors, Messrs. G. E. Dicks and J. H. Westwood.

On the motion of Mr. H. L. Reason, Mr. Flavell was warmly thanked for his services as President during the past session.

Mr. Robert Buchanan, Past-President of the Institution of British Foundrymen, then addressed the members on the subject of Liquid Contraction.

Some Notes on Liquid Contraction.

Liquid contraction is a very important phenomenon in foundry practice, and undoubtedly occupies the foundryman's daily and hourly attention. It is known variously as liquid contraction, sinking, or drawing. To the author's mind, these are different names for the same manifestation.

It was at the author's suggestion the late Mr. George Hailstone took this subject for a thesis in connection with his Carnegie Scholarship, but he did not live long enough to carry the study beyond the preliminary stage.

Early in the year as this is, it has seen the publication of a very important and valuable Paper on the subject, "Volume Changes of Cast Iron on Solidification," by Mr. Oliver Smalley, of Gateshead-on-Tyne.

This Paper carries the subject further than has hitherto been done, and the insight, knowledge, and enthusiasm displayed are of a very high order.

Ten or more years ago at one of the annual Conferences held in Glasgow, in the course of the discussion on a Paper, the author pointed out that liquid contraction in one part of a casting was due to expansion in another part. No one took any notice of the statement, but the author has had no reason to change his opinion meantime, and Mr. Smalley confirms this.

It may be useful to trace the sequence of events which make this possible. One does not usually think of iron in the cupola as being expanded by the heat until the particles are completely separated, or, as we say, melted. That is, there is an expansion of the solid iron up to the melting point of the iron. This solid expansion before melting is mentioned because it is the converse contraction when the casting is cooling which causes foundrymen to make the patterns one-eighth or one-tenth larger than the desired casting. This has nothing to do with the liquid contraction with which it is sought to deal, but is mentioned so that the position may be made clear. During the course of the heating up of the cupola by the blast the graphite becomes dissolved into the iron at about 1,000 deg. C., and the iron finally melts at 1,300 to 1,400 deg. C., according to its general composition.

It has to be noted that when the carbon goes into solution at about 1,000 deg. C. there is a stop in the rise of temperature, so far as the iron is concerned, until the carbon is all dissolved. This hidden, or latent, heat is given back again when the iron cools down to a similar temperature. This manifestation probably plays an important part, seeing that for a brief period the cooling of the iron stops while the carbon is becoming free carbon, or graphite, again. We have a similar sequence in the recalescence of a carbon steel.

When the iron is molten and in the ladle, the whole of the carbon is in the combined form. How long it will stay in the combined form depends on the composition and temperature of the iron, but especially the temperature. With dull iron from a cupola over-charged with coke one has seen liberated carbon (kish) fly off the ladle as it was carried along. This, however, is an exception.

Condition of the Metal in the Ladle.

The iron in the ladle, notwithstanding its temperature, is of a higher specific gravity than the iron was before it was melted. That means that the molecules of iron are closer to each other than they were when cold. If it were not so, then a red-hot runner head would not float when put into a hot ladle of iron, as it does. To get it to melt it must be pushed down with a "skimmer."

It is hardly necessary to mention that a number of elements, other than carbon, are also dissolved on the molten iron, but these are left unnoticed for the time being.

Liquid Contraction due to Expansion Elsewhere.

Professor Turner, by his extensometer, showed that at one point in the cooling of grey cast iron the casting is actually larger than the casting pattern.

When a casting, all of one section, is run, no liquid contraction takes place, unless possibly a slight sign of it shows at the runner. The author has often watched the behaviour of the runner head on such castings which he had cut runners. For a short time the head remained as filled, but in 10 or 15 seconds the head went down until it was almost empty. This marked the expansion in the casting due to the carbon coming out of solution. The emptying of the runner head is an example of liquid contraction. The runner head had a thicker section than any part of the casting. If the runner head were not making up for the expansion of the casting, why should the runner head sink?

Liquid Contraction of a Cube of Cast Iron.

The author made a number of castings, practically cubes, weighing one ton each. They were "fed," but why? The iron, when it was poured into the mould, was greater in density than at any subsequent period of time. If the density had remained unchanged, no "sinking," or liquid contraction, would have taken place, and no "feeding" would have been required. As it was, the outsides of the cube began to solidify first and expand outwards, and the liquid, or semi-liquid, metal followed it. In short, liquid contraction is mostly due to solid, or semi-solid, expansion.

The author was puzzled for a long time; in fact, he is somewhat puzzled yet, as to why the expansion of the solidifying iron does not extend towards the more liquid iron instead of away from it. Whether this converse action takes place or no depends on the rigidity of the walls of the mould or chill.

Chill Moulds.

A chill mould offers most resistance to expansion; a drysand or loam mould less; and a greensand mould least of all. When the iron is poured into a rigid chill with open top the metal rises in the open top, it does not sink. In this case the expansion takes place towards the softer centre, not away from it.

XUM

Drysand or Loam Moulds.

A less effect, but in the same direction, takes place in a drysand or a loam mould. Many years ago the author saw a good, old-time moulder make use of this knowledge. He cast a large marine cylinder, and as soon as the mould was full he poured water on the runner head to solidify it. By doing so he stopped expansion pressure causing any return of the metal up the drop gates.

It is this partial rigidity of the walls of a drysand or loam mould which, causing a partial reflex action of the expansion, makes castings made by these methods more solid than they would be otherwise.

Greensand Moulds.

In greensand moulds the wall resistance to expansion is comparatively slight, and so almost no resistance to expansion takes place. The liquid contraction which takes place in a boss or heavy part of the casting is simply due to "a following on" of the liquid iron. This "follow on" may be due to gravity, or "head," owing to height above the expanding part, but not necessarily so in all circumstances.

Liquid Contraction in Various Grades of Iron.

In considering this part of the subject, it is proposed to deal with grey irons only. Mottled and white irons form quite a distinct set of problems by themselves, both obscure and difficult.

No. 1 grade of iron is usually rich in free carbon, and readily shows liquid contraction if parts of the casting have widely differing solidifying periods.

Some years ago, at a meeting of the Council of the Institution, the author asked the members in general, "What do you do when you want to stop 'sinking'?" As the Council was, and is, made up largely of eminent foundrymen, they all replied "scrap up." The author then asked, "Why does 'scrapping up' a mixture stop sinking?" The reply was, "We do not know why; but it does."

This brings us to what we may consider as fairly true, that a structure which conforms to what may be defined as a "close No. 4" in the casting gives the minimum of liquid contraction, or "draw," or "sinking," three names for the same manifestation.

Mr. Smalley, in his recent valuable Paper, gives, it is thought, the correct answer to the question of why "scrapping-up" lessens the liquid contraction. It lessens the period of solidification, and so shortens the time during which the thinner section of the casting can rob the heavier parts.

There are probably a number of factors affecting this result, such as lowering the total silicon, increase of sulphur, etc., but the main cause is a lessening of the size of the graphite carbon flakes. In other words, the solid expansion is less because the graphite is less largely developed.

Manganese as a Lessener of Liquid Contraction.

It is definite that manganese has a useful influence in lessening the hardening effect of sulphur, though the supposed evil effects of sulphur have been much over-emphasised. There is no component of cast iron but under suitable circumstances has a useful function.

When manganese is present in slight excess above what will neutralise the sulphur, this excess forms manganese carbide; a compound with a high melting and solidifying temperature. This manganese carbide has the useful function of forming crystals at a high temperature while the metal is still largely fluid. These crystals act as nuclei for crystallisation in general, and so hasten solidification, a result to be desired. Manganese in excess causes hardness, and the author is of opinion that 1 per cent. is beneficial.

Effect of Casting Temperature on Solidification.

That casting iron hot gives the greatest solidity is correct, but the reason for it being so is not obvious. Moulders in general do not think so, and they are in the habit of holding metal in the ladle until it is under the hottest, if allowed to do so. Possibly their care of having a smooth casting is one of the reasons, but the fact remains that they do hold the metal before pouring.

At first sight one would agree that when the iron is under the hottest when poured, the period of solidification would be shorter, and so there would be less opportunity for liquid contraction to take place locally. It is only an idea, but possibly the size of the carbon liberated prevents as full a liquid contraction as would take place were the iron dull. In the case of dull iron carbon, coalescence and carbon growth take place because the iron *is* dull.

With hot iron the carbon remains in a finely-divided form, especially if the silicon is fairly low. These observations do not by any means cover the whole field of solid or semi-solid expansion and its converse, liquid contraction.

One fact may be mentioned which is rather contradictory to what has been stated regarding the relation between the expansion and contraction mentioned. When making castings of a solid, regular form and weighing 5 lbs. or 6 lbs. each, the iron was one brand of hematite mixed with the heads from similar castings made the previous day. For some time progress was made without any trouble, and then the castings began to "draw." No new iron or coke had been supplied, and this fact localised the trouble as being within ourselves. After a considerable investigation it was found that the foreman had put an extra weight on to the blow-off valve of the blower. The cupola was being worked with just the amount of coke which would give hot iron, and the extra weight on the blow-off valve gave an excess of air for the quantity of coke used.

Evidently there must have been some oxidation of the silicon and the carbon, and possibly of the iron itself. In any case, when the extra weight was taken off the valve, the "sinking" stopped.

Influence of Over-Blown Pig-Iron.

In addition to the causes already mentioned, there is no doubt that high temperatures and heavy blast used in the making of pig-iron tend towards liquid contraction, especially if the blast furnace is not working normally. Some time ago one of the members had a great deal of trouble from this cause. The analysis of the castings was quite satisfactory, but, notwithstanding this, the castings continued to be "drawn." Almost certainly this was due to free oxides in the pig-iron. Unfortunately analysis does not show the presence of free oxides, but the results showed no other likely cause of "drawing" or "sinking." Shortly afterwards the blast furnace which was blamed was put out of blast owing to the number of complaints made regarding the quality of the pig-iron produced.

It is fortunate that at the present time the Cast Iron Research Association, under the able directorship of Dr. Percy Longmuir, is engaged in an investigation of the conditions under which liquid contraction takes place.

From the experiments of Mr. Smalley and others it will be readily understood that the problem is a very difficult and obscure one. There is every expectation that this investigation will be of great value to the industry.

Discussion.

MR. D. WILKINSON said he understood Mr. Buchanan to give it as his opinion that liquid contraction was largely due to solid or semi-solid expansion in other parts of the casting. That was certainly an idea well worth following up, and he (Mr. Wilkinson) intended to follow it up if possible. When casting in chill they were not so much troubled as when using a green-sand mould. Dry-sand and loam moulds were also less liable to this defect. He could not quite see that it was the expansion that came on just at the point of solidification that was really responsible for draw holes. There was a certain amount of colour lent to Mr. Buchanan's remarks by the fact that in white iron a small runner which froze immediately did reduce contraction. In fact, he could mention more than one small steel casting which could not be made successfully unless run through the smallest possible runner in a very thin part of the casting. And with grey-iron castings, in his early days, one way of getting over otherwise insuperable difficulties regarding contraction was to use the smallest possible runner and cast the castings hot.

MONS. RONCERAY, JUN., said that during the war he had seen in France shells 4 in. dia. and weighing 1 cwt. cast without a riser.

Mr. A. S. Beech (member of the London Branch) expressed the opinion that very often what were thought to be drawn castings were not due to this reason, but were really gas-escape holes. The gases, for some reason or other, could not get away from the core or from the mould.

Porosity was very commonly found in sections of castings which heated the sand considerably all round, or in sections which were almost enclosed by metal. It was quite natural to expect that this heating of the sand produced gases which could not escape very easily through the sand, and which therefore took the easiest course and escaped through the liquid metal, leaving a trace of their exit behind them. It was very often seen on an automobile cylinder, where the porosity in nearly every case can be found between the bores.

If the porosity was due to a drawn casting through a thick and thin section of metal coming together, it would be more natural to find it on the top flange, which is much thicker than the barrel section immediately adjoining it, but it was very seldom found here—it was generally found at the bottom of the junction of the two barrels, and he felt sure that this was due to insufficient venting at this most important point.

He did not suggest that there was no such thing as drawn castings or segregations, but he wished to point out that porosity was often put down to these effects, whereas, as a matter of fact, it was frequently due to insufficient venting at most important points of either the core or the sand.

Mr. F. C. Edwards contended that segregation was a totally different thing from a draw. He mentioned a case which occurred a few weeks ago in connection with what they called a stool casting. There were very heavy masses of metal in the four corners, which were strung together by a light sort of frame. The frame and stool were cast on a plate. Repeatedly they had draws in the four corners where the heavy mass of metal joined on the thin ribs, but they did not occur anywhere else.

Mr. H. Field considered the porosity or otherwise of the sand had some bearing on the question. The first step a moulder often took was to substitute raw red sand for milled facing sand to give greater porosity, and that often worked on bosses in sharp angles. He was satisfied that although the metal might have something to do with their difficulties, there were many other causes, among which gating and running were important. It was true that certain brands of pig-iron, and certain deliveries of certain brands, appeared to give more trouble in this respect than others, but the conclusions reached on one day often proved mistaken when next applied, and, so far as he knew, there was no published work dealing with the relationship between composition and liquid contraction. Various workers had named silicon, manganese, phosphorus, and total carbon as important showing the complex nature of the problem.

THE AUTHOR'S REPLY.

Replying upon the discussion, Mr. Buchanan expressed the pleasure which they all felt at seeing Mons. Ronceray, junior, in the room. He did not put down gas as one of the causes. Did not all the authorities tell them that if they cast their metal hot they got a minimum of sinking? It was also recognised, he thought, that a hot metal contained more gas than a dull iron. Why should they have a minimum of sinking with the maximum of gas present? He was not going to answer that question. If they wanted to have sinking *in excelsis* they used a dull iron which contained less gas. How was it that they got a greater sinking with a smaller quantity of gas present? As regarded the minimising or absolute doing away with sinking by the use of small runners, he agreed that on a certain type of casting that was very useful, but it was only of limited use. As to the use of the word chill, he thought that being among foundrymen he was quite safe in doing so. When he was among engineers he always spoke of denseners. Discussing the use of raw red sand, he said that was a palliative which was only of use where the bosses were small. It would not be applicable, say, to the liquid contraction which would take place in a flywheel or similar castings.

LONDON BRANCH.

Prominent Metallurgist Declines Important Office.

Before dealing with the ordinary business, Mr. V. C. Faulkner, Hon. Secretary, announced to the members of the London Branch of the Institute of British Foundrymen, at their last meeting, held on Saturday, April 21, that Mr. Wesley Lambert (Branch-President), and the Branch itself, had been very highly honoured because, at the Council meeting of the Institution, which took place in Birmingham during the previous week, a unanimous wish was expressed that Mr. Lambert should accept the Junior Vice-Presidency of the Institution. (Applause.) Mr. Lambert had accepted that, with the reservation that permission would be granted by the directors of his firm. Unfortunately, however, Mr. Lambert had to travel extensively, and might be kept away for six months in the course of a year, and his directors did not consider that, from this reason, he could do justice to the post. Therefore they could not accord the necessary permission. They were all very sorry, said Mr. Faulkner, but, at the same time, the honour had been paid to Mr. Lambert and to the Branch, and he was sure he was expressing the feelings of all the members when he said how much they, as a Branch, appreciated it.

Mr. Lambert, referring to the invitation to him to occupy the Junior Vice-Presidential Chair of the whole Institution, said he felt very much honoured indeed to know that he had the confidence of the Council of the Institution to such an extent. The proposition was put by Mr. Stubbs, a Past-President, and supported by Mr. Riddell, also a Past-President and one of the oldest members of the Institution, and he himself was very gratified to find that the vote was absolutely unanimous. He had written to the General Secretary in the following terms:—

Dear Mr. Hollinworth,—I regret to inform you that my acceptance of the office of Junior Vice-President of the Institution of British Foundrymen, with the prospect of my passing to the Presidential Chair, is not considered opportune by my directors, and I therefore cannot confirm my tentative acceptance of the office. Representations have been made to me that, in view of one or two projects now before my firm, it is desirable that my full services shall be available for the next two or three years, and it may even be necessary for me to have an extended absence abroad.

I have been very happy in my association with the London Branch, and also at the meetings of the parent Institution, but as you personally are aware, I am a busy man, and the Institution of British Foundrymen is only one of a number of societies and institutes to which I have the honour to belong, all of which claim a number of attendances throughout the year.

I look forward to a long association with the I.B.F. as a member, and will do my best to further its interests by any means within my power.

I shall be glad if you will kindly make it known that the decision conveyed above has been arrived at only after due consideration, and it is my wish that it be regarded as definite.

The proposition that I be elected to fill the office of Junior Vice-President, put forward by Mr. Oliver Stubbs and seconded by Mr. M. Riddell—both Past-Presidents of the Institution—and the unanimous vote which followed, conferred upon me an honour which cannot be eclipsed even by the honour of the position itself.—Yours, etc.,

(Signed) W. Lambert.

April 19, 1923.

Continuing, the Branch-President said he had accepted the resolution in a tentative manner, as he would have to submit to the decision of his directors. His directors had informed him that they had in mind one or two projects which they believed would occupy the whole of his time, and which would require all his energies. However, perhaps at some future time he would be at liberty to take office, and, if so, if there was anything he could do for the Institution he would be very pleased to do it.

XUM

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—The position in the Cleveland iron trade remains, so far, practically as last reported, business continuing limited in scope owing to the uncertainty of events on the Ruhr and the possibility of an early settlement of the difficulties now existing, which would, of course, have far-reaching effects on home industries generally. Consequently, buying is for the time being virtually suspended, many of the large consumers having substantial quantities to be delivered on contract account, and therefore holding off from further commitments until the outlook becomes more clearly defined. At this week's Tees-side market there was some disposition to shade prices, and quotations were marked irregular, Cleveland No. 3 G.M.B. having been sold at 125s. for early delivery, or half-a-crown below recent figures, but the volume of actual transactions was quite small. The business passing in other grades was negligible, and on the basis of the No. 3 price quotations would be: No. 1, 130s.; silicious, 125s.; No. 4 foundry, 120s.; and No. 4 forge, 117s. 6d.

A certain weakness has also developed in the hematite trade, and while some producers are adhering to 125s. for East Coast mixed numbers, others are willing to accept 122s. 6d. per ton. Continental demand is extremely quiet at the moment, and home inquiry is also dull. On the West Coast hematite market prices are steady, Bessemer mixed numbers being quoted at £6 15s. to £6 17s. 6d. per ton, delivered at Glasgow, Sheffield and Birmingham, and at £6 17s. 6d. to £7 per ton f.o.b. Liverpool. The demand for the various qualities of low phosphorus iron is fairly well maintained.

MANCHESTER.—Local demand for foundry iron is on a disappointing scale, and fresh business extremely scarce, consumers of this quality declaring that the prices now obtainable for castings will not stand the present cost of pig-iron. But actually there is not much business in castings just now, for if there were iron-founders would be more willing to buy up the cheap foundry scrap, which is readily obtainable. There has been no change in the Cleveland or Scottish prices for foundry iron, while most of the Midland makers of pig-iron are well sold up to the end of June, and still base their Manchester price upon £5 10s. per ton at the furnaces. As there is no reduction in the railway rates this means from 118s. 3d. to 120s. for common iron when delivered in South Lancashire.

THE MIDLANDS.—In the South Staffordshire area, as elsewhere, market movements in pig-iron are mostly directed to supplies to meet immediate needs, for which quotations remain firm. The volume of this trade, however, is very small, because requirements are normally well covered, and there is practically no surplus production. The offering of a little iron for prompt delivery is spasmodic, and quite accidental. Fortunately, manufacturers are fairly well sold forward. In some cases the expected output is covered until well into June—to the end of the month sometimes. Sales, therefore, indicate continued firmness of quotations for the time being, unless, of course, there is in the meantime a substantial drop in coke prices.

SCOTLAND.—The improvement recently reported in the export demand for pig-iron has not been maintained, and business in the Glasgow market is again quiet. Makers' prices, however, remain unchanged, and as most of them are pretty well sold up to the end of June they see no necessity to reduce quotations meantime. The advices from both Germany and Italy are that there is an improvement in the quantity of domestic iron available, and that there is in consequence less need to import foreign iron. No. 3 Middlesbrough is now quoted at £6 12s. 6d. at Falkirk, and No. 4 foundry at 2s. 6d. per ton less, but No. 3 Scotch can be got at fully 10s. per ton less. Middlesbrough iron is therefore only being bought where the consumer considers it essential to have high phosphorus iron.

Finished Iron.

With regard to this section of the trade, there is little fresh to report. In general, home manufacturers are well supplied with orders for several weeks to come, but there is a scarcity of new business to take the place of the contracts now being worked off, and Continental material is being offered with greater freedom and at rather cheaper prices, but quotations for Belgian bars are reported at £1 per ton below South Staffordshire prices, but so far, few orders or contracts appear to have gone abroad, one reason for this being that the conditions as to deliveries are not regarded as very favourable. There is nothing, however, to disturb the market for crown and marked bars. Makers report that they hold some quite satisfactory contracts, the railways and carriage building companies having been good customers, and that they are assured of full employment for some time ahead. A satisfactory trade is also being done in gas strip.

Steel.

Conditions in most sections of the steel industry have developed some irregularity of late, and so far trade on the whole has not progressed to the satisfactory extent suggested by the optimistic opinions expressed earlier in the year. The demand for steel products, both semi and finished, has experienced a distinct check, and fresh business is by no means so readily forthcoming as makers would desire. In the alloy market the position of ferro-manganese is firm. The output is more than covered by the current demand, and there is no prospect at present of increasing the make. Prices are firmly maintained at £18 for home and £20 export. Business in soft steel billets is quiet, as the works are well booked for the next three months, but are anxious for orders for late in the year. There is no material change in tin-plate, and business is on a restricted scale, whilst prices are inclined to weaken. Second-hand lots of tin-plates have been done at 24s. 3d. basis I.C. f.o.b. works' port for delivery over the next two months, and generally makers are not so firm in their quotations as they were, and are now willing to accept 25s. 3d. basis I.C. f.o.b. works' port for substantial orders.

Scrap.

Reports from the various markets for scrap material disclose a diminished demand generally, buying on behalf of the foundry trade being restricted by lack of new business, while inquiries for steel qualities have also decreased in volume. Good broken machinery iron, in convenient foundry sizes, can be bought in South Wales at 90s. per ton, while in the Lancashire district dealers are quoting 95s. for the same class of material, but so far as can be ascertained, they are not selling. It is now difficult to find a buyer at £5 for the best broken "textile" scrap, a material which used to sell in Lancashire at near the price of Scotch No. 3. The present price of Scotch iron is £2 per ton more than that of textile scrap. Altogether the whole market may be described as dull and depressed, and the supply is very much in excess of the demand.

Metals.

Copper.—During the past few days fluctuations in standard values of this metal have been comparatively unimportant in range, tending on the whole, however, to somewhat lower levels, as compared with the average figures for the previous week. Home consumers' demands are fairly well maintained, but are mainly for prompt delivery, a very small volume of forward buying having been booked. The Continental demand, however, continues poor, German buying especially being of very small proportions. The market in America is dull. Producers appear to be firm with regard to prices, but, on the other hand, domestic consumers are expressing an increasing reluctance to buy. Current quotations:—*Cash*: Wednesday, £72 5s.; Thursday, £72; Friday, £71 5s.; Monday, £70 10s.; Tuesday, £69 15s. *Three Months*: Wednesday, £73 2s. 6d.; Thursday, £72 17s. 6d.; Friday, £72; Monday, £71 7s. 6d.; Tuesday, £70 10s.

Tin.—Although lacking in the sensational features associated with the recent boom in metals, standard tin last week marked a sharp recovery in values, the bearing tendency in evidence of late having subsided with results more favourable to the bull element. The monthly statistics, about to be issued, are expected to make a good showing, and the probability is that an attempt is being made to force the market upward in anticipation of that event. Home consumption continues on a moderate scale, and there seems little prospect of any material increase during the near future. Meanwhile, America has kept out of the market, having apparently sufficient metal in hand to satisfy her immediate requirements. Buying from that quarter, however, is expected shortly to resume, and in this event a fillip would probably be given to the market. Current quotations:—*Cash*: Wednesday, £210 5s.; Thursday, £209 10s.; Friday, £211; Monday, £210 15s.; Tuesday, £213. *Three*

IRON AND STEEL MARKETS—*continued.*

Months: Wednesday, £210 10s.; Thursday, 209 10s.; Friday, £211; Monday, £210 15s.; Tuesday, £213.

Spelter.—The market for this metal continues quiet and uneventful, with values marking slightly lower levels. Metal continues to arrive freely from the Continent, and stocks in London warehouses are beginning to accumulate. In America, also, the market has been easier in consequence of increasing output. The market on the Continent has been quiet, with perhaps rather less disposition to make sales. Current quotations:—*Ordinary*: Wednesday, £32 17s. 6d.; Thursday, £32 10s.; Friday, £31 17s. 6d.; Monday, £32 5s.; Tuesday, £32 2s. 6d.

Lead.—Business in soft foreign pig remains slow, with values on the whole a shade easier. Supplies have been arriving more freely, and apparently are more than sufficient to satisfy the demand. The manufacturing trades at the moment are rather quiet, but once building operations are in full swing again an increased call for metal may be confidently anticipated. Current quotations:—*Soft foreign (prompt)*: Wednesday, £26; Thursday, £25 10s.; Friday, £25 7s. 6d.; Monday, £25 15s.; Tuesday, £25 12s. 6d.

Company News.

Walworth-Munzing, Limited, 90-96, Union Street, Southwark, London, S.E.—Capital £25,000 in £1 shares. Ironfounders.

Dispatch Engineering Company, Limited, 1a, Pentlow Street, Putney, London, S.W.—Capital £1,000. Permanent directors: A. Cocks and E. Carter.

Jones Bi-Metals Company, Limited, Wilders Drive, Warwick Road, Birmingham.—Capital £1,000 in £1 shares. Directors: G. Jones and B. T. Davis.

Ledward & Beckett, Limited, Parliament Mansions, Victoria Street, London, S.W.—Capital £20,000. Engineers. E. H. Beckett is permanent governing director.

Albion Rotary Engines, Limited, Albion House, 59-61, New Oxford Street, London, W.C.—Capital £900 in 600 A. shares of £1 and 6,000 B. shares of 1s. Directors: E. J. Turquand and W. J. L. Sandy.

John Farrington, Limited, Ancoats Copper Works, 69, Chapel Street, Ancoats, Manchester.—Capital £2,000. Coppersmiths, brassfounders, etc. Directors: J. Farrington, H. Fielden, A. L. W. Ward and W. N. Cook.

Clayton & Shuttleworth, Limited.—Deficit for 1922, £12,469, after transferring £100,000 from reserve fund for further writing down stocks and for development expenditure; brought forward, £54,914; carried forward, £42,445.

Armstrong Construction Company, Limited, 8, Great George Street, Westminster, London, S.W.1.—Capital £250,000 in £1 shares. Constructional, mechanical, civil, electrical, mining, engineers, ironmasters, colliery proprietors, etc.

Babcock & Wilcox, Limited.—Net profit, £787,601; brought forward, £71,243; dividend, 9 per cent., and bonus 3 per cent. on ordinary, both free of tax; reserve fund, £200,000; staff pension fund, £20,000; carried forward, £194,126.

Gazette.

MESSRS. C. E. HANCOCK and W. N. Burgess, engineers, Queen Camel and Sparkford, Somerset, under the style of Hancock & Burgess, have dissolved partnership.

THE PARTNERSHIP heretofore subsisting between Messrs. C. Chorley and R. J. Chorley, iron and steel merchants, Warrington, under the style of John Chorley, has been dissolved. R. J. Chorley continues.

THE PARTNERSHIP heretofore subsisting between Messrs. A. J. Oborn and W. J. Hughes, engineering contractors, Crown Chambers, Salubrious Place, Swansea, under the style Oborn & Hughes, has been dissolved.

THE SHAREHOLDERS of the British Griffin Chilled Iron & Steel Company, Limited, have decided that the company be wound up voluntarily, with Sir William Henry Peat, 11, Ironmonger Lane, London, E.C.2, as liquidator.

MESSRS. J. R. STERLING, C. R. St. John and W. Smith, engineers, 66, Victoria Street, Westminster, S.W., trading under the style of John Sterling & Company, have dissolved partnership. Mr. J. R. Sterling continues.

THE PARTNERSHIP heretofore subsisting between Messrs. C. Souness and J. K. Green, engineers, Milburn House, Newcastle-upon-Tyne, under the style of Souness & Green, has been dissolved. J. K. Green will continue the business as J. K. Green & Company.

Trade Talk.

SMEETON-WRIGHT FURNACES, LIMITED, have removed their offices from 56, Victoria Street, to St. Stephen's House, Victoria Embankment, Westminster, London, S.W.1.

THE GLASGOW TRAMWAYS COMMITTEE have recommended the Corporation to accept the Cargo Fleet Iron Company's tender for the supply of 5,000 tons of rails at £11 per ton.

H. F. SPENCER & COMPANY, iron and steel merchants, of Prudential Chambers, Lichfield Street, Wolverhampton, have removed their London office to 212A, Shaftesbury Avenue, W.C.2.

RUMOURS have again been current in the London and Birmingham Stock Exchanges this week in regard to an amalgamation between Guest, Keen & Nettlefolds, Limited, and Baldwins, Limited.

THE UNDERFEED STOKER COMPANY, LIMITED, Coventry House, South Place, London, E.C.2, have lately taken orders for 45 travelling grate stokers, 22 Underfeed stokers, one with conveyor and 6 arches.

JOHN A. SMEETON, LIMITED, engineers, contractors and merchants, have removed their offices from 56, Victoria Street, S.W.1, to St. Stephen's House, Victoria Embankment, Westminster, London, S.W.1.

THE LONDON AND NORTH-EASTERN RAILWAY COMPANY'S new wagon works at Favordale, Darlington, are expected to be ready in June. At present only about half of the original scheme has been carried out, but eventually the works will be doubled in size.

MR. E. J. GEORGE, general manager of the Consett Iron Company, Limited, mentioned at a meeting last week, that the company, who were reconstructing the steel works, hoped that a portion of the steel plant would be in operation before the end of the present year.

THE SHOTTS IRON COMPANY, LIMITED, have resolved to allot to the holders of the issued ordinary shares whose names were on the register as on April 20, 200,000 ordinary shares of £1 each, at a premium of 10s. per share, the issue to be at the rate of one new ordinary share for each of the issued ordinary shares.

STILL ANOTHER ORGANISATION, the Copper and Brass Extended Uses Council, is being brought into existence by certain of the non-ferrous metal associations. The council will investigate present and new uses of copper, brass and bronze, and provide members with metals more suitable to their purposes. Mr. G. W. Mullins is the chairman, and Mr. G. Squires, King's Court, 115, Colmore Row, Birmingham, is the secretary.

MR. ARTHUR MARKS, F.I.C., who has been for the past seven years metallurgist and head of the Testing Department of Messrs. Harland & Wolff, Limited, Belfast, has resigned his position. Mr. Marks, who has had large practical foundry experience with diesel and reciprocating engine castings and forgings, and considerable experience of oil-fired ships, has now been appointed as metallurgical adviser to Messrs. A. Harper, Sons & Bean, Limited, Dudley, Tipton and Smethwick.

MR. J. R. CLYNES, M.P., made an appeal for harmony in the relationship between employers and employed when performing the ceremony of relighting four blast furnaces at the Stanton Ironworks recently. These furnaces have been out of operation for two years. Addressing a gathering of workpeople, Mr. Clynes commented on the excellent relations which had so long prevailed between masters and men at Stanton, a feature for which the Whitley Council and the men's Shop Committees had been largely responsible.

AT THE annual meeting of the East Midlands Branch of the Institution of British Foundrymen, Mr. S. H. Russell (Leicester) was elected as the new president. Mr. J. Lucas (Loughborough) was elected vice-president, in the place of Mr. Russell, and Messrs. H. Pemberton (Derby), E. Stevenson (Notts), and J. C. Cox (Ilkeston) were re-elected. Messrs. S. Worcester (Leicester), C. W. Bigg (Derby), and Blackwell (Loughborough) were elected to the committee, and Mr. H. Bunting was re-elected as hon. secretary.

THE HULL TRAMWAYS COMMITTEE has received a setback in regard to the contract for 2,000 tons of rails which they gave to a Belgian firm in preference to British makers. They were apparently pleased with the money they had saved by placing the contract abroad, and gave further orders for an additional thousand tons of Belgian rails at over £2 per ton more than the first lot, and proceeded to make application to the Government Unemployment Grants Committee for a grant to enable them to lay the new tram tracks in Hull streets. When the committee met, last week, a letter was read from the Unemployment Grants Committee, stating that the grant could not be given towards the work, as the contract for material had been placed abroad.

MACNAB & Co.

TABOR MOULDING MACHINES (TABOR PATENTS)

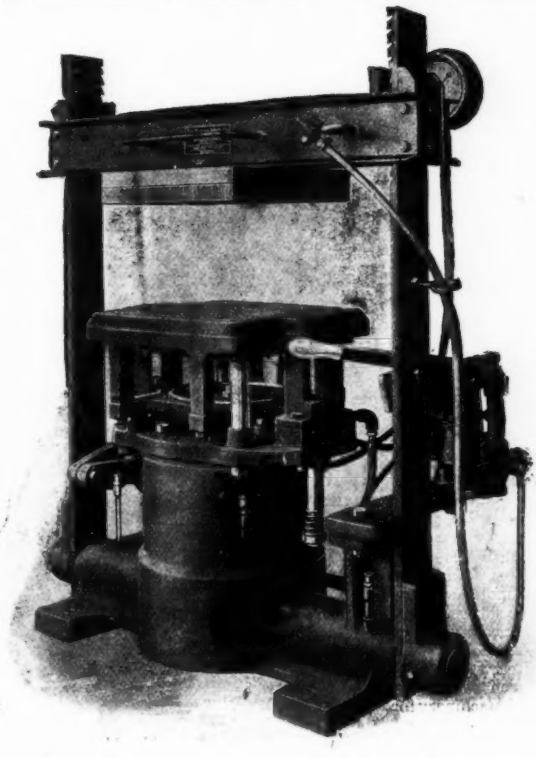
For Every Class of Work.

Pit Type and Portable Combination Shockless Jar Ramming Power Roll-over and Pattern Drawing Machines; Power Squeezing and Jar Squeezing Machines; Shockless Jarring Machines, etc., etc.

SPECIAL FEATURES AND ADVANTAGES:

Accurate Definite Draw with Permanent Accurate Alignment.

All Operations Controlled by One Lever.



Uniformity in size of Castings produced.

All Moulds squeezed alike to whatever Pressure Required.

Minimum Percentage of Wasters.

The above illustrates the TABOR POWER SQUEEZING "SPLIT PATTERN" MOULDING MACHINE, specially suitable for all small patterns which can be split in halves or for flat back work.

Capacities and Dimensions furnished upon application:

56/8, Eagle Street, Southampton Row, London, W.C.1.

Works: TOTTENHAM, LONDON, N.17.

WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash	69 15 0
Three months	70 10 0
Electrolytic	79 5 0
Tough	73 0 0
Best selected	73 0 0
Sheets	106 0 0
India	93 0 0
Wire bars	79 5 0
Do. May	79 5 0
Do. June	79 5 0
Ingot bars	79 5 0
H.C. wire rods	83 15 0
Off. aver., cash, Mar.	73 18 4
Do. 3 mths., Mar.	74 12 2½
Do. Settlement Mar.	73 18 1½
Do. Electro, Mar.	81 14 7½
Do. B.S., Mar.	77 7 9½
Aver. spot price, copper, Mar.	73 17 3½
Do. Electro, Mar.	82 0 0
Solid drawn tubes	14½d.
Brazed tubes	14½d.
Wire	11d.
Yellow metal rods	7½d.
Do. 4x4 Squares	9d.
Do. 4x3 Sheets	10d.

BRASS.

Solid drawn tubes	13d.
Brazed tubes	14½d.
Rods, drawn	11¼d.
Rods, extruded or rolled	7½d.
Sheets to 10 w.g.	11d.
Wire	10¾d.
Rolled metal	10½d.

TIN.

	£ s. d.
Standard cash	213 0 0
Three months	213 0 0
English	213 0 0
Bars	215 0 0
Chinese	212 0 0
Straits	218 10 0
Australian	218 0 0
Eastern	216 5 0
Banca	216 10 0
Off. aver., cash, Mar.	219 15 0
Do. 3 mths., Mar.	220 18 10½
Do. Sttlment, Mar.	219 15 0¾
Aver., spot, Mar.	219 13 4

SPELTER.

	£ s. d.
Ordinary	32 2 6
Remelted	30 10 0
Hard	28 10 0
Electro 99.9	37 0 0
English	32 15 0
India	28 10 6
Prime Western	32 7 0
Zinc dust	49 0 0
Zinc ashes	13 0 0
Off. aver., Mar.	36 15 4½
Aver., spot, Mar.	36 14 4¾

LEAD.

	£ s. d.
Soft foreign ppt	25 12 6
English	27 0 0
Off. average, Mar.	28 15 1¼
Average, spot, Mar.	28 16 3¾

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	43 0 0
Do. V.M. ex whf.	42 0 0
Dutch	42 0 0
Rods	50 0 0
Boiler plates	41 0 0
Battery plates	42 0 0

ANTIMONY.

	£ s. d.
English regulus	30 10 0
Special brands	36 15 0
Chinese	28 0 0
Crude	24 0 0

QUICKSILVER.

	£ s. d.
Quicksilver	10 0 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
45/50%	£13 2 6
75%	£20 17 6
Ferro-vanadium—	
35/40%	16/9 lb. va.
Ferro-molybdenum—	
70/75% c. free	9/3 lb. mo.
Ferro-titanium—	
23/25%, carbonless	1/2½ lb.
Ferro-phosphorus, 20/23%,	£29
Ferro-tungsten—	
80/85%, carbon free	1/5½ lb.
Tungsten metal powder—	
98/99%	1/10½ lb.
Ferro-chrome—	
4/6% car.	£23 10
6/8% car.	£22 10
8/10% car.	£21 10
Ferro-chrome—	
Max. 2% car.	£52 0
Max. 1% car.	£62 0
Max. 0.70% car.	£72 0
67/70%, carbonless	1/6½ lb.
Nickel—99%, cubes or pellets	£135 0
Cobalt metal—98/99%	12/- lb.
Aluminium—98/99%	£115
Metallic Chromium—	
96/98%	4/6 lb.
Ferro-manganese (net)—	
76/80%, loose	£18
76/80%, packed	£19
76/80%, export	£20
Metallic manganese—	
94/96%, carbonless	2/- lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£ s. d. 2 6
Finished bars, 18% tungsten	3 0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares 3 in. to 8 in. inclusive 4d. lb.

Rounds and squares under ½ in. to ¼ in. 3d. lb.

Flats under 1 in. by ¾ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness 3d. lb.

Bevels of approved sizes and sections 6d. lb.

If in coils 3d. lb.

Bars cut to length 10% extra

Scrap from high-speed tool steel—

Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£ s. d.	£ s. d.
Heavy steel	5 0 0	5 7 6
Bundled steel & shrngs.	4 10 0	5 5 0
Mixed iron & steel	4 7 6	4 15 0
Heavy cast iron		4 10 0
Good machinery for foundries		4 10 0

Cleveland—	
Heavy steel	4 15 0
Steel turnings	3 7 6
Cast-iron borings	3 7 6
Heavy forge	5 7 6
Bushelled scrap	4 15 0
Cast-iron scrap	4 15 0

Lancashire—	
Cast-iron scrap	4 15 0
Heavy wrought	5 5 0
Steel turnings	3 12 6

London — Merchants' buying prices delivered yard.

Copper (clean)	65 0 0
Brass (clean)	38 0 0
Lead (less usual draft)	23 10 0
Tea lead	21 10 0
Zinc	23 0 0
New aluminium cuttings	65 0 0
Braziery copper	56 0 0
Gun metal	50 0 0
Hollow pewter	170 0 0
Shaped black pewter	90 0 0

PIG-IRON.

N. E. Coast—	
Foundry No. 1	130/-
Foundry No. 3	125/-
Forge No. 4	117/6
Mottled	—
Hematite No. 1	123/6
Hematite M/Nos.	122/6
Midlands—	
Staffs. common	—
,, part-mine forge	—
,, ,, foundry	—
,, Cold blast, ord.	190/-
,, ,, roll iron	200/-
,, basic	—
Northants forge	100/-
,, foundry No 3	110/-
,, basic	115/-
Derbyshire forge	107/6
,, foundry No. 3	116/3
,, basic	115/-
Scotland—	
Foundry No. 1	125/-
,, No. 3	120/-
Hematite M/Nos.	127/6
Sheffield (d/d district)—	
Derby forge	111/-
,, foundry No. 3	120/-
Lincs. forge	110/-
,, foundry No. 3	115/-
,, basic	120/-
E.C. hematite	135/3
W.C. hematite	135/- to 137/6

All d/d in the district.

Lancashire (d/d eq. Man.)	—
Derby forge	—
,, foundry No. 3	128/6
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
,, foundry No. 3	—
Dalzell, No. 3	137/-
Summerlee, No. 3	137/-
Glengarnock, No. 3	137/-
Gartsherrie, No. 3	137/-
Monkland, No. 3	137/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£ s. d.
Bars (cr.)	£12 to 12 10 0
Angles	12 5 0
Tees to 3 united ins.	12 10 0
Nut and bolt	11 15 0
Hoops	15 0 0
Marked bars (Staffs.)	14 10 0
Gas strip	13 0 0
Bolts and nuts, ¾ in. × 4 in.	20 10 0

Steel—	
Ship plates	10 10 0
Boiler plates	14 0 0
Chequer plates	11 5 0
Angles	10 0 0
Tees	11 0 0
Channels	10 10 0
Joists	10 0 0
Rounds & squares 3 in. to 5½ in.	12 5 0
Rounds under 3 in. to ¾ in.	12 0 0
Flats, over 5 in. wide and up	12 10 0
Flats, 5 in. to 1½ in.	11 15 0
Rails, heavy	10 10 0
Fishplates	14 10 0
Hoops (Staffs.)	13 0 0
Black sheets, 24 g.	14 12 6
Galv. cor. sheets, 24 g.	19 10 0
Galv. fencing wire, 8 g. plain	18 5 0
Rivets, ¾ in. dia.	14 15 0
Billets, soft	10 0 0
Billets, hard	10 15 0
Sheet bars	£9/11/6 to 9 15 0
Tin bars	10 0 0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 3½
Sheet	1 4½
Wire	1 4½
Rods	1 3
Tubes	1 6½
Castings	1 1½

Delivery 3 cwt. free to any town.

10% phosphor copper, £40 above price of B.S.

15% phosphor copper, £50 above price of B.S.

Phosphor tin (5%), £30 above price of English ingots.

CHARLES CLIFFORD & SON, LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/4 to 1/10
To 18 in. wide	1/4½ to 1/10½
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6½ to 2/0½
Ingots for spoons and forks	9d. to 1/3
Ingots rolled to spoon size	1/- to 1/6
Wire round—	
3/0 to 10 G...	1/6½ to 2/1½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	32.76
No. 2 foundry, Valley	31.00
No. 2 foundry, Birm...	27.00
Basic	32.77
Bessemer	32.77
Malleable	32.77
Grey forge	32.27
Ferro-manganese 80% delivered	125.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y, at mill	43.00
Bess. billets	45.00
O.-h. billets	45.00
O.-h. sheet bars	47.50
Wire rods	50.00
	Cents.
Iron bars, Phila.	2.82
Steel bars	2.50
Tank plates	2.50
Beams, etc.	2.50
Skelp, grooved steel	2.35
Skelp, sheared steel	2.35
Steel hoops	3.30
Sheets, black, No. 28	4.00
Sheets, galv., No. 28	5.25
Sheets, blue an'l'd, 9&10	3.25
Wire nails	2.90
Plain wire	2.65
Barbed wire, galv.	3.70
Tinplate, 100-lb. box	$6.00

COKE (at ovens).

Welsh foundry	40/- to 45/-
,, furnace	30/- to 35/-
Durham & North. fdy.	47/6
,, furnace	39/-
Other Districts, fndy	45/- to 47/6
,, furnace	32/6 to 37/6

TINPLATES.

f.o.b. Bristol Channel ports.

I.C.Cokes,	20×14, box	25/3
,,	28×20, ,,	50/6
,,	20×10, ,,	37/3
,,	18¾×14, ,,	26/3
C.W.	20×14, ,,	23/3
,,	28×20, ,,	47/3
,,	20×10, ,,	33/-
,,	18¾×14, ,,	23/9
Terneplates	28×20, ,,	46/3

TUBES.

	Up to and incl. 6 in.
Gas ..	..57½% } Tube prices
Water	..52½% } are
Steam	..47½% } now free.

SWEDISH IRON.

Bars, hammered basis sizes—Basis price £22 to £23

	£ s. d.
Rolled Ordinary—Assortment ..	17 5 0
Nail Rods—	
Square, round and flats ..	to 17 15 0

Keg Steel nom. £38 to £40
Faggot Steel nom. £30 to £32
Blooms—
Single welded .. £10 to £11
Billets—
Single and double welded .. .. £13 to £14
Pig-iron—
Grey, white or mottled £6 15 to £7 5 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.	
April 25	72	5	0	No change
„ 26	72	0	0	dec. 5/-
„ 27	71	5	0	„ 15/-
„ 30	70	10	0	„ 15/-
May 1	69	15	0	„ 15/-

Electrolytic Copper.

April 25	80	10	0	dec.	5/-
„ 26	80	5	0	„	5/-
„ 27	80	0	0	„	5/-
„ 30	79	10	0	„	10/-
May 1	79	5	0	„	5/-

Standard Tin (cash).

April 25	210	5	0	dec.	110/-
„ 26	209	10	0	„	15/-
„ 27	211	0	0	inc.	30/-
„ 30	210	15	0	dec.	5/-
May 1	213	0	0	inc.	45/-

Tin (English ingots).

April 25	210	5	0	dec.	115/-
„ 26	209	10	0	„	15/-
„ 27	211	0	0	inc.	30/-
„ 30	210	15	0	dec.	5/-
May 1	213	0	0	inc.	45/-

Zinc Sheets (English).

April 25	43	0	0	No change
„ 26	43	0	0	„
„ 27	43	0	0	„
„ 30	43	0	0	„
May 1	43	0	0	„

Spelter (ordinary).

April 25	32	17	6	dec.	15/-
„ 26	32	10	0	„	7/6
„ 27	31	17	6	„	12/6
„ 30	32	5	0	inc.	7/6
May 1	32	2	6	dec.	2/6

Lead (English).

April 25	27	5	0	dec.	5/-
„ 26	26	15	0	„	10/-
„ 27	26	15	0	No change	
„ 30	27	0	0	inc.	5/-
May 1	27	0	0	No change	

AVERAGE MONTHLY PRICES OF EAST COAST HEMATITE MIXED NUMBERS F.O.T.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Yearly Average.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1915	.. 83 11	.. 88 6	.. 94 8	..107 0	..102 6	..101 3	.. 98 9	.. 98 7½	.. 96 6	..104 0	..124 1	..130 0	..106 11½
1916	..133 9	..140 0	..136 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..128 1½	
1917	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	
1918	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	
1919	..122 6	..122 6	..122 6	..122 6	..179 2	..190 0	..197 6	..200 0	..200 0	..200 0	..200 0	..171 4	
1920	..220 0	..220 0	..240 0	..260 0	..260 0	..260 0	..260 0	..260 0	..260 0	..260 0	..260 0	..251 8	
1921	..240 0	..220 0	..180 0	..180 0	..160 0	..160 0	..160 0	..137 0	..127 6	..117 6	..104 6	..162 2	
1922	.. 97 6	.. 91 7½	..100 0	.. 98 6	.. 97 1½	.. 94 7	.. 93 6	.. 90 9	.. 89 7	.. 91 10½	.. 93 0	.. 93 2	.. 94 5½

AVERAGE PRICES OF STEEL RAILS.

Year.	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Yearly Average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1908	.. 6 2 6	.. 6 0 0	.. 6 0 0	.. 5 15 6	.. 5 15 0	.. 5 15 0	.. 5 15 0	.. 5 15 0	.. 5 15 0	.. 5 15 0	.. 5 15 0	.. 5 10 0	.. 5 16 3
1909	.. 5 5 0	.. 5 5 0	.. 5 5 0	.. 5 0 0	.. 5 5 0	.. 5 5 0	.. 5 5 0	.. 5 5 0	.. 5 5 0	.. 5 5 0	.. 5 5 0	.. 5 5 0	.. 5 5 0
1910	.. 5 5 0	.. 5 7 6	.. 5 7 6	.. 5 7 6	.. 5 10 0	.. 5 10 0	.. 5 10 0	.. 5 10 0	.. 5 10 0	.. 5 10 0	.. 5 10 0	.. 5 10 0	.. 5 8 11½
1911	.. 5 15 0	.. 5 15 0	.. 5 15 0	.. 5 12 6	.. 5 12 6	.. 5 12 6	.. 5 12 6	.. 5 12 6	.. 5 12 6	.. 5 12 6	.. 5 12 6	.. 5 12 6	.. 5 13 1½
1912	.. 5 13 1	.. 5 15 0	.. 5 15 7	.. 6 1 6	.. 6 6 3	.. 6 7 6	.. 6 8 0	.. 6 11 3	.. 6 12 6	.. 6 12 6	.. 6 13 9	.. 6 4 4	
1913	.. 6 15 0	.. 6 14 4½	.. 6 12 6	.. 6 12 6	.. 6 12 6	.. 6 12 6	.. 6 12 6	.. 6 12 6	.. 6 10 0	.. 6 10 0	.. 6 10 0	.. 6 10 0	.. 6 12 0
1914	.. 6 10 0	.. 6 10 0	.. 6 6 3	.. 6 0 0	.. 6 0 0	.. 6 0 0	.. 5 14 0	.. 6 2 6	.. 6 13 9	.. 6 12 0	.. 6 7 6	.. 6 7 6	.. 6 5 3½
1915	.. 6 10 6	.. 6 17 6	.. 7 5 0	.. 7 12 6	.. 7 12 6	.. 7 17 6	.. 8 17 6	.. 9 2 6	.. 9 2 6	.. 9 2 6	.. 9 7 6	.. 10 10 6	.. 8 6 6½
1916	..10 19 4	..11 0 0	..11 0 0	..10 18 9	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 9 10
1917	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6
1918	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6
1919	..10 17 6	..13 7 6	..13 7 6	..13 7 6	..15 0 0	..15 10 0	..16 0 0	..16 10 0	..16 10 0	..16 10 0	..16 10 0	..17 5 0	..14 12 11
1920	..18 15 0	..19 5 0	..20 7 6	..22 0 0	..23 0 0	..23 0 0	..24 0 0	..25 0 0	..25 0 0	..25 0 0	..25 0 0	..25 0 0	..22 18 11½
1921	..23 5 0	..20 4 0	..18 0 0	..17 0 0	..15 0 0	..15 0 0	..14 0 0	..14 0 0	..14 0 0	..11 12 6	..10 10 0	..10 0 0	..15 4 3
1922	.. 9 10 0	.. 9 10 0	.. 9 10 0	.. 9 10 0	.. 9 10 0	.. 9 10 0	.. 9 10 0	.. 9 0 0	.. 8 15 0	.. 8 15 0	.. 8 15 0	.. 8 15 0	.. 9 4 2

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5, SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.,

IRON & STEEL SCRAP

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,

ROYAL EXCHANGE, MIDDLESBROUGH.

93, HOPE STREET, GLASGOW.

SMALL ADVERTISEMENTS.

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Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 7 words per line. Minimum charge for one insertion 3/-.

SITUATIONS VACANT AND WANTED.

FOREMAN MOULDER required for a Scottish Steel Foundry; must be experienced in Green Sand work, competent to handle unskilled and semi-skilled labour; Foundry capacity, 100 tons per week; open shop; state age, experience, and salary required.—Apply Box 442, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

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ENGINEER (Manchester) is open to represent a firm stocking large quantities of good second-hand Steam Tubes and Fittings.—Address "Traveller," Box 402, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Stereet, Adelphi, London, W.C.2.

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TO CLOSE A TRUST ESTATE.

TENDERS are invited for the purchase of this well-known and old-established business as a going concern, including the Goodwill, Stock-in-Trade, and Book Debts.

For further particulars and permission to inspect apply to the undersigned, to whom Tenders should be sent on or before the 18th May, 1923.

GRYLLS & PAIGE,
Solicitors.

REDRUTH,
28th April, 1923.

PUBLICATION.

ENGINEERING WORKS, FOUNDRIES and FOUNDRY PLANT.—Complete lists of the Engineers, Iron, Steel, Brass and Aluminium Founders in Great Britain and Ireland, and also classified lists of Manufacturers and Suppliers of all Foundry Plant and Requisites, is contained in "Ryland's Directory of the Colliery, Iron, Steel, Tinplate, Metal, Engineering, Hardware and Allied Trades." Published by Eagland & Co., Ltd., Bessemer House, Adelphi, London, W.C.2. Price 42s. bound in cloth, 52s. morocco, net.

PATENTS.

INVENTORS Advice, Handbook and Consultations Free. KING'S PATENT AGENCY, LIMITED, Director, B. T. King, Regd. Patent Agent, 146a, Queen Victoria Street, London; 36 years' references.

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MACHINERY, PLANT, &c.

250-kw. GENERATING SET; Triple Expansion Engine, by Bellis & Morcom; direct-coupled to E.C.C. Generator; 460/550 volts, 380 revs.

160-kw. 3-PHASE GENERATING SET, by Scott & Mountain; Compound Engine, direct-coupled to 3-Phase Alternator; 550 volts, 174 amps., 40 cycles.

100-b.h.p. GAS ENGINE, 16½ in. cyl., 24 in. stroke, magneto ignition; by Bates & Co.

Powerful Horizontal Worm-Geared WINCH,; pair of 9½ in. cyls., drum 2 ft. 6 in. diam, 4 ft. 7 in. face, grooved for 1¼-in. wire rope; by Clarke, Chapman & Co.

LOCO-TYPE BOILER; barrel 7 ft. 6 in. long x 3 ft. diameter; reinsure 80 lbs. pressure.

New LOCO-TYPE BOILER, about 4 ft. 6 in. long, with barrel 2 ft. 6 in. x 23⅜ in. diameter; suitable for a working pressure of 200 lbs. per sq. inch. Makers, Marshall & Sons, Gainsborough. Suitable for road locomotion.

Catalogue of Stock Machinery, 6,000 Lots,
Free on application. Inspection invited.

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

THREE-THROW GEARED PUMP, by Worthington; Plungers, 3-in. diameter x 3-in. stroke; Genuine Weir Boiler Feed Pump, capacity 4,500 gallons per hour; Vertical Boiler, by Robey, 10-ft. high x 4-ft. diameter; nine nearly new Steel Hopper Wagons, 5 tons, 4 ft. 8½ in. gauge; 10-kw. 110-volt Steam Generating Set, by Allen; 31-h.p. latest type Crossley Gas Engine.—Apply, HARRY H. GARDAM & COMPANY, LIMITED, Staines.

TWO NEW RUMBLERS, strong and well finished; geared drive; £22. Root's Blower, large size, £7 10s., f.o.r.—Apply 554, Fishponds Road, Bristol.

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Two 300-kw. Belliss B.T.H. LIGHTING AND TRACTION SETS, compound wound; in first-class order, with Condensing Plant and Switchgear.

Two 500-kw. Belliss B.T.H. ALTERNATOR SETS, 2,000 volts, single-phase (Engines will be sold separately if required), with Condensing Plant.

Four Babcock Land Type BOILERS, 8,500 lbs. capacity, 160-180 lbs. press.

One Mixed-pressure Belliss TURBINE, with 1,000-kw. single-phase ALTERNATOR (2-phase carcase), 2,000 volts, 60 periods; and 333-kw., 500 volt D.C. GENERATOR, connected tandem, complete with CONTRAFLO CONDENSER and MOTOR-DRIVEN PUMPS.

One MOTOR GENERATOR, 250 kw., comprising single-phase Synchronous Motor, D.C. Compound Generator, 200 kw., and D.C. Shunt Generator, 150 kw.

COUNTY BOROUGH OF CROYDON ELECTRICITY WORKS, FACTORY LANE, CROYDON.

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SIX HYDRAULIC MOULDING MACHINES, Type A.3 (Bonvillain & Ronceray). Good working order. Low price. Inspection Southern district.

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A COMPLETE STEEL MELTING PLANT, by Green, including Converters (Bessemer), Cupolas, Charging Platform, etc. Half original cost.

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SECOND ELECTRIC STEEL FURNACE PLANT,

complete with

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